

DatuSurvey™

User Guide

Version 5.0.0

November 2016

This User's Guide applies to both software packages available under the umbrella of DatuSurvey™ including:

**DatuSurvey Professional, and
DatuSurvey Enterprise**

Datumate Geomatics Expert Systems

For more information please visit our website at www.datumate.com, or contact us at support@datumate.com.

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Contents

1	Using this Document	4
2	Overview of DatuSurvey™ Packages	5
2.1	Background	5
2.2	Principles of Operation	5
2.3	Working with DatuSurvey™	6
2.3.1	In the Field.....	7
2.3.2	In the Office.....	7
2.4	Accuracy of Measurements	8
3	Installing DatuSurvey™	10
3.1	System Requirements	10
3.2	Installing DatuSurvey™	10
3.2.1	Important Information about DatuGram™3D Backward Compatibility	10
3.3	DatuSurvey™ Licenses	11
3.3.1	Stand-Alone Perpetual Software License	11
3.3.2	Stand-Alone Time-Based Software License	11
3.3.3	Network Perpetual Software License	11
3.3.4	Network Time-Based Software License.....	11
3.4	Activating DatuSurvey™	12
3.5	Reinstalling DatuSurvey™	15
3.6	Transferring DatuSurvey™ to a Different Computer	15
3.7	Upgrading DatuSurvey™	15
3.8	Updating License Key	15
4	Field Work: Taking Photos and Measuring Control Points	17
4.1	Choosing your Camera and Lens	17
4.2	Photographing the Survey Area	19
4.3	Geo-Ref / Scale.....	24
4.3.1	Measuring Control Points for Image Geo-Referencing	25
4.3.2	Measuring Distances for Image Scaling.....	27
5	Calibrating Your Camera.....	28
5.1	Calibration Procedure	28
5.2	Field Calibration Image Set	33
5.3	Calibration Library.....	34
6	Working with DatuSurvey™	36
6.1	Starting DatuSurvey™ Application	36
6.2	Working with Jobs.....	37
6.2.1	Opening a New Job.....	37
6.2.2	Opening an Existing Job.....	38
6.3	Step 1: Images – Loading Images, Camera Calibration, linking images and Managing of Clusters.	39
6.3.1	Short Baseline issues	44
6.3.2	Manually Linking Image Clusters.....	44
6.3.3	Viewing Clusters in 3D.....	47
6.4	Step 2: Geo-Ref / Scale	47

6.4.1	How to work in the Geo-Ref/Scale stage	48
6.4.2	Working in Geo-Tag mode	53
6.4.3	Working in Rough Scale mode	53
6.4.4	Working in Scale mode.....	53
6.4.5	Working in Geo-Ref mode.....	56
6.4.6	Importing Control Points.....	56
6.4.7	Marking Control Points	59
6.4.8	Anchoring Control Points	61
6.4.9	Adding a New Ground Control Point.....	64
6.4.10	Adding a New Floating Control Point	65
6.4.11	The Geo-Referencing/Scaling Marking Accuracy Indicator	66
6.4.12	Marking Accuracy List	66
6.4.13	Export Camera Calibration	67
6.5	Step 3: Measure & Draw – Marking and Creating New Points	67
6.5.1	Layers and Objects	68
6.5.2	The “Measure & Draw” Toolbar.....	69
6.5.3	The New-Points List.....	71
6.5.4	The New-Point Properties Bar	71
6.5.5	Viewing Images	72
6.5.6	Marking New Map Entities.....	74
6.5.7	Working with the Ruler Tool	78
6.5.8	Other “Measure & Draw” Window Properties.....	78
6.6	Step 4: Approve – Reviewing, Correcting and Approving Marked Points.....	81
6.6.1	Approving New Points.....	82
6.6.2	Approving Topo Points	82
6.6.3	General Approval Guidelines.....	83
6.7	Step 5: View & Export – Previewing and Exporting to Exchangeable Formats	84
6.7.1	Exporting Job Data	86
6.7.2	Volume Calculations.....	87
7	DatuSurvey™ Menu Options	95
7.1	File Menu	95
7.1.1	Save as.....	95
7.1.2	Export	95
7.1.3	Close & Archive Job	95
7.2	Tools Menu	95
7.2.1	Settings Window	95
7.2.2	Managing and Using Codes and Blocks	99
7.2.3	Client License Manager	103
7.2.4	Generate Dense Point Cloud	106
7.3	View Menu	106
7.3.1	Sparse Cloud Point	106
7.4	Help Menu	107
7.4.1	About DatuSurvey™	107

7.4.2	Checking for DatuSurvey™ Software Update	110
7.4.3	Opening the Welcome Screen.....	111
7.4.4	Basic Steps Presentation	112

1 Using this Document

The DatuSurvey™ User Guide will help you:

- Understand the principles of operation of the software packages available from Datamate.
- Plan and execute your fieldwork.
- Use the software, make measurements, draw maps, and/or generate 3D Point Clouds and Orthophotos from the images taken in the field.

Within this document, you will find comments, tips, and answers to frequently asked questions. These are indicated by the following admonitions:



This icon signifies comments that are important for the user. They will help you to make maximum use of the DatuSurvey™ software.



This icon signifies operational tips that may help you optimize your work in the field and in the office.



This icon signifies warnings that are important for the user.

2 Overview of DatuSurvey™ Packages

2.1 Background

DatuSurvey™ software (Previously DatuGram™3D) is a Field-to-Plan application allowing surveyors to make accurate geodetic measurements and draw draft CAD plans and maps directly from images photographed using standard digital cameras. DatuSurvey™ is applicable for surveying projects on a 1:250 scale, such as as-built surveys, volumetric analysis of stockpiles, geodetic mapping of buildings, roads, tunnels, junctions, engineering structures, forensic and accident scenes, mines, earth works, archaeological artifacts, film sets, and much more.

Starting with Version 5.0.0 DatuSurvey™ will be available in 2 different packages as follows:

1. **DatuSurvey Professional** – This package is suitable for surveyors who are interested in working the traditional way and generate 2D and 3D maps.
2. **DatuSurvey Enterprise** – This package is has all the functionalities of DatuSurvey Professional but in addition is has the capability of generating and working with dense point clouds as well as generating Orthophotos.

This manual will describe the full functionality of all features covered by both packages, features not available for a certain package will be either disabled or will not be shown and the user will not have access to them.

2.2 Principles of Operation

The DatuSurvey™ software employs the principles of **photogrammetry**. Photogrammetry is the science of taking accurate measurements from photographs. The output of photogrammetry is typically a CAD map, plan, drawing, or a 3D-model of some real-world object or scene.

<p><i>“photo”</i> – light <i>“gram”</i> – drawing <i>“metry”</i> – measurement</p>
--

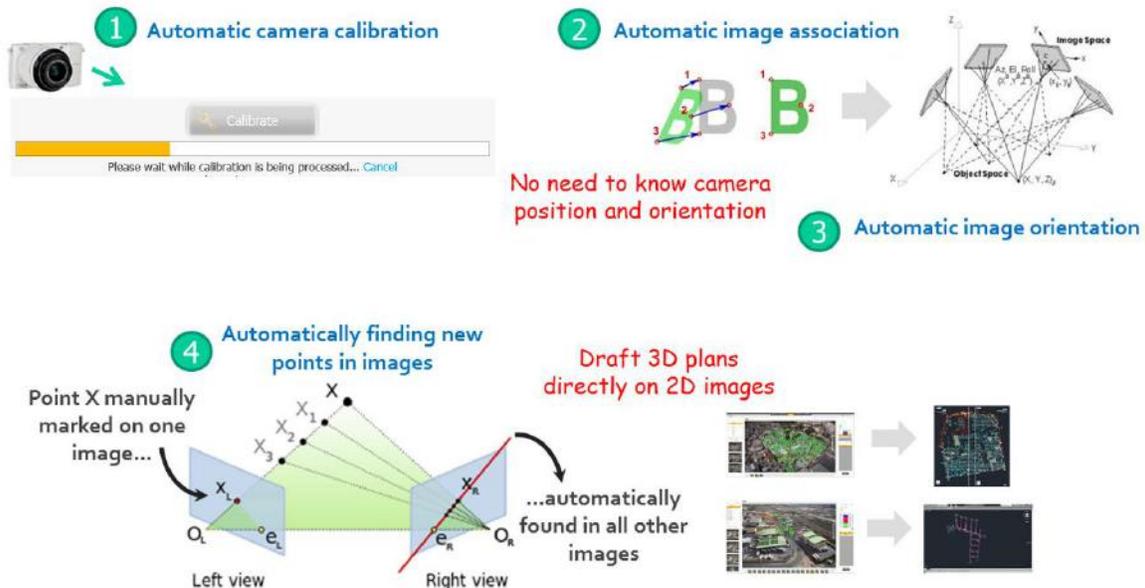


Figure 1: Principles of Operation of DatuSurvey™

DatuSurvey™ automatically calculates the internal camera system parameters using a simple automatic self-calibration procedure, thus allowing the user to use any regular digital camera (1 – Figure 1). When uploading the images, DatuSurvey™ employs image processing and bundle adjustment algorithms to automatically calculate the relative orientation of the images (2 and 3 – Figure 1), such that only two of the images must be geo-referenced. Subsequently, DatuSurvey™ automatically locates any point the user marks on one image in at least two additional images (4 – Figure 1), thus allowing DatuSurvey™ to apply triangulation to find the 3D-coordinates of the new point. This permits users to draft objects directly on one image while the application automatically finds them in all other images, thus eliminating the need for stereoscopic digitization of images. Moreover, DatuSurvey™ allows the automatic extraction of a digital terrain model (DTM) of the survey area. This is highly useful for topographic surveys and volumetric analyses. While drafting on the images, the surveyor may use templates containing layers and codes. Consequently, the generated 3D model of the survey area may be saved in CAD DXF file format, so that it can be opened for further processing in any CAD software package.

As a result, DatuSurvey™ streamlines and accelerates the Field-to-Plan process, i.e., the process of capturing field data and the drafting of CAD maps and models from the data.

2.3 Working with DatuSurvey™

Working with DatuSurvey™ is very simple.

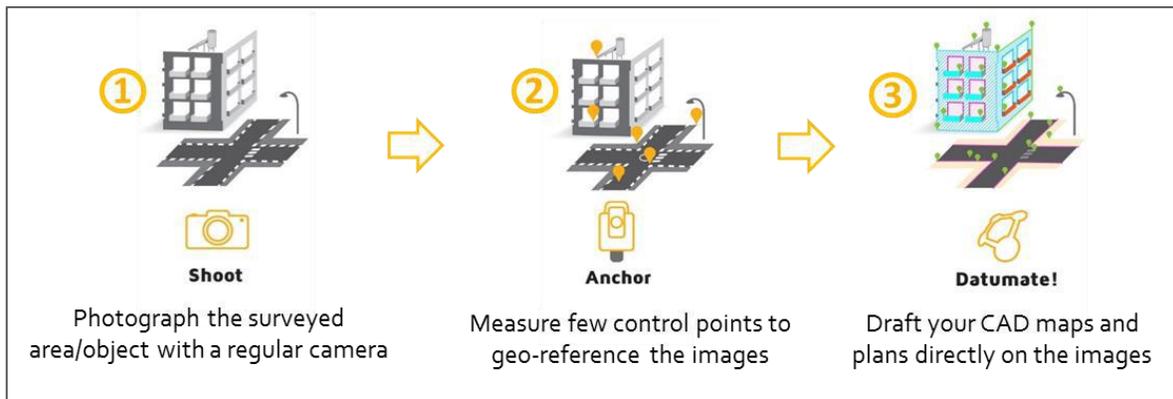


Figure 2: Working with DatuSurvey™

2.3.1 In the Field

The surveyor takes multiple photographs of the surveyed object or the survey area from different angles (1 – Figure 2), and measures the coordinates of several (minimum of three) reference points (or control points) using a total positioning station (TPS) or an RTK device, in either a local or national grid (2 – Figure 2), or alternatively measures two or more slope distances. The control points are used to geo-reference the images, i.e., anchor the images to the local or national grid, and the slope distances are used to correctly scale the whole project to allow seeing right measurements.

2.3.2 In the Office

The surveyor uploads the images to the DatuSurvey™ software that automatically associates all images to one another, by employing advanced image processing algorithms that find homological tie points and similar features, and calculates the relative orientation of the images. Optionally the surveyor can load the TPS measurement file of the control points and digitize at least three of the control points in at least two of images each in order to geo-reference all images to the local or national grid. Or alternatively, choose to add scale-only without control points or geo-referencing (without orientation and position), by adding 2 slope distance measurements in two images each. Both geo-ref and scale are optional, hence it is possible to build and see a model without measurements.

Users may then draft their CAD model directly on the images, or automatically generate a DTM for any topo-surface that appears in the images (3 – Figure 2). The DatuSurvey™ software ultimately produces a DXF file of the generated 3D CAD model, as well as a file that lists all the points that were measured from the images, specifying their names, associated codes, and (x,y,h) coordinates, as well as the accuracy of each measurement, i.e. the (x,y,h) residuals for each point.

In addition, the surveyor may opt to highlight, on the geo-referenced images, any additional points that were measured by field crews. In this way, the user may verify the quality of the measurements undertaken by field crews and identify and correct in the office any discrepancy in the field measurements.

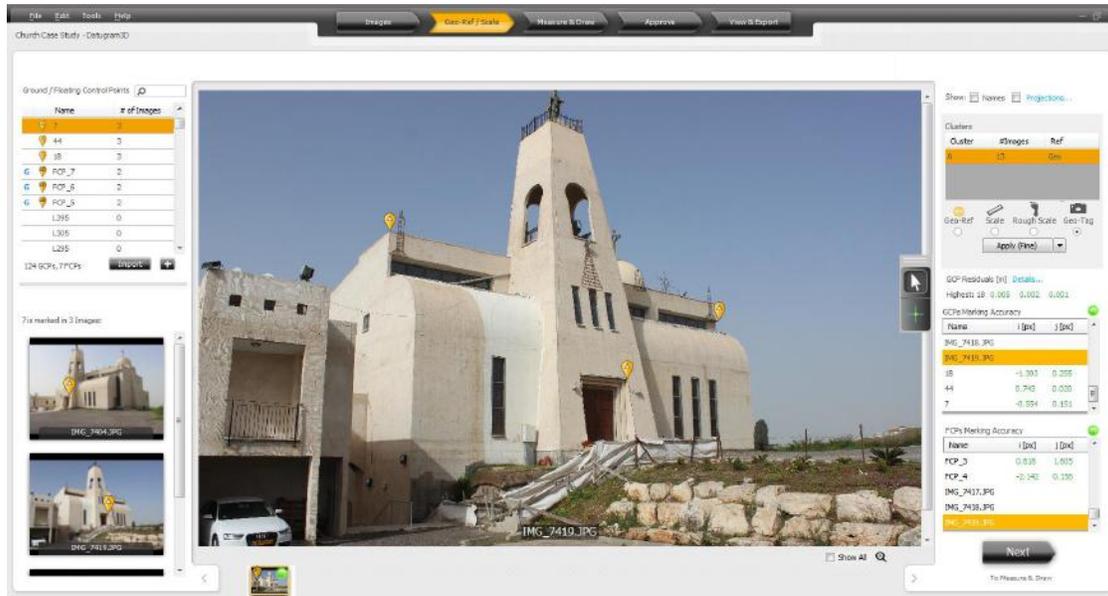


Figure 3: Typical DatuSurvey™ Work Area Showing Control Points

2.4 Accuracy of Measurements

In geo-referenced or scaled jobs, the accuracy of measurements made on the images by DatuSurvey™ depends on the following parameters:

1. **The camera resolution and the distance between the camera and the measured object.** The accuracy of measurements made on the images by DatuSurvey™ is a factor of the camera's resolution and the proximity to the measured object. Typically, an 18-megapixel camera provides a 1 to 2 centimeter (3 to 6 hundredth of a foot) measurement accuracy at a distance of about 100 to 150 meters (110 to 160 yards, 330 to 480 feet).
2. **The precision with which measurements in the survey area are done. This refers to the coordinates of the reference control points or to the measured distances.** These should be as exact as possible as they set an accuracy baseline for all the measurement and drafting related to the images. When you measure Ground control points, make sure you have several of them on a surface showing a very clear feature, such as marks on the ground or marks on walls. This will assure taking a very precise measurement. If you try to measure building corners using an RTK device on buildings you may have to get away from the corner a little bit to make sure that the laser is getting it.
3. **The maximum angle between images of the surveyed area.** The accuracy of measurements made on the images by DatuSurvey™ is impaired when the maximum angle between images of the surveyed area is less than 30°. For best measurement accuracy, the maximum angle between images of the surveyed area should be close to 90°. This applies only when images are taken in oblique mode and not in vertical mode.
4. **The scattering of the control points or measured distances and the accuracy of digitizing them in the images.** For best measurement accuracy, control points for image

geo-referencing should be chosen on the perimeter of the surveyed area and measured distances should be as long as possible so that measurements made on the images by DatuSurvey™ are interpolated, rather than extrapolated, from the measured distances or points. Moreover, control points should be well distributed in 3D space, i.e., relative to both depth and height, and digitized as accurately as possible in the geo-referenced images. For more details on measuring control points in the field, please refer to Chapter 4.

Various quality control measures in DatuSurvey™ provide the user with detailed information about the accuracy of measurements. First, after the images have been geo-referenced, DatuSurvey™ verifies the accuracy of the image geo-referencing or scaling by comparing the relative orientation of the control points or the distances to the relative orientation of the images. The **Geo-Referencing Quality Indicator** or **Scale Quality Indicator** provide color indication (green, yellow or red) of the accuracy of the referencing of the photogrammetric model. Furthermore, after calculating the coordinates of the new points measured from the images, DatuSurvey™ provides the accuracy of each measurement, i.e., the (x,y,h) residuals for every point.

3 Installing DatuSurvey™

3.1 System Requirements

The DatuSurvey™ software is designed to work on common office PCs and standard laptops.

- Operating system requirements
 - Windows 7: Enterprise, Ultimate or Professional (64-bit only).
 - Windows 8.1: Enterprise or Professional (64-bit only).
 - Windows 10: Enterprise or Professional (64-bit only).



DatuSurvey™ works now only under 64-bit operating systems. The 64-bit environment provides enhanced support for larger quantities of images and superior responsiveness.

- CPU and hard disk requirements
 - CPU: minimum Intel core i5 (or equivalent); recommended i7.
 - CPU RAM: minimum 4GB RAM; recommended 8GB.
 - Hard disk: minimum 50GB of free space; recommended 100GB.
- Screen and graphics card requirements
 - Display resolution: at least 1600X900 with True Color; recommended 1920x1080.
 - NVidia Graphics card: at least 0.5GB; recommended 1GB.
- Connectivity requirements
 - Available Internet connection for installation, activation and updates.
- Compatibility
 - DXF file format: DXF 2006 onwards.

3.2 Installing DatuSurvey™

3.2.1 Important Information about DatuGram™3D Backward Compatibility

This Version of DatuSurvey™ contains major changes. In jobs created using earlier versions images will need to be relinked. Make sure the proper camera calibration is selected from the library as camera calibration was improved to generate better results. All control points and objects defined in the prior version will be kept and may be used. Note that if you save the job in DatuSurvey™ 5.0.0 (or a higher version), you will not be able to reopen it in earlier versions.

Additionally, all volumes calculated in jobs created in prior versions will need to be recalculated.

3.3 DatuSurvey™ Licenses

Below is a general description of the licensing options. Some of the options mentioned below may not apply to all different software packages.

3.3.1 Stand-Alone Perpetual Software License

A regular software license of DatuSurvey™ allows the installation of one copy of the software on a single computer or “seat”. This copy of the software may be re-installed on that computer, or transferred to another computer after uninstalling from the first computer. This type of license has no expiration date and it includes maintenance for one year. The maintenance agreement will need to be renewed on a yearly base after the first year. Maintenance includes support and software updates.

3.3.2 Stand-Alone Time-Based Software License

A regular software license of DatuSurvey™ allows the installation of one copy of the software on a single computer or “seat”. This copy of the software may be re-installed on that computer, or transferred to another computer after uninstalling from the first computer. This type of license has an expiration date after which the use of the software will not be permitted unless the license is renewed. This type of license include maintenance till the license expiration date.

The system will give you proper messages if your license is about to expire.

3.3.3 Network Perpetual Software License

A network license of DatuSurvey™ is intended for organizations that require the flexibility to be able to use DatuSurvey™ on several computers on a local network. This licensing method enables installation of the DatuSurvey™ application on any number of PCs in a local network. The application can be used concurrently on the number of computers, or “seats” that were purchased as part of the floating license.

Starting with version 4.5.1 it is possible to borrow a network license to work with it while not connected to the LAN. This can be done using the menu option “Tools/Client License Manager” option and is discussed in details in section 7.2.3 below.

3.3.4 Network Time-Based Software License

Same as the Perpetual Network License, except That it has an expiration date after which the use of the software will not be permitted unless the license is renewed. This type of license include maintenance till the license expiration date.

The system will give you proper messages if your license is about to expire.

3.4 Activating DatuSurvey™

1. If this is the first time the software is installed on your computer, the “DatuSurvey™ Activation License” will open. You should provide a license key file (V2C file that you received from Datamate) or fill in the activation license request form.

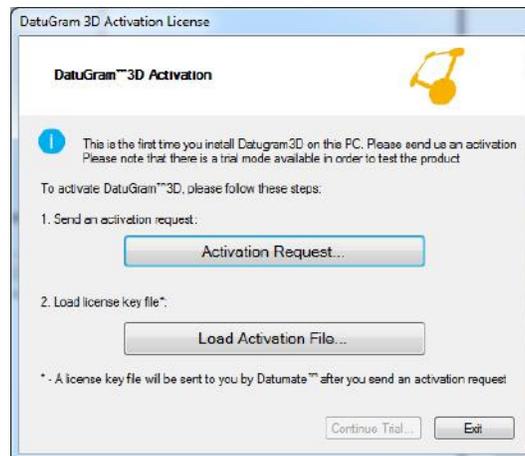


Figure 4: DatuSurvey™ Activation License

2. If you have purchased a license, you should have received with the invoice, the License ID (**LicID**). Keep it for the activation step.
3. When the “Activation License Request” form is displayed fill in all the fields and click **Send Request**.
4. There are three types of licenses available:
 - **Trial** – this type of license is free of charge, and lets you use the full power of DatuSurvey™ for a period of 30 days. To get this type of license you do not need a LicID.
 - **Full** – this is a full purchased license of DatuSurvey™ for a single computer. This includes perpetual and time-based.
 - **Network** – this is a full purchased type of license, allowing installation of DatuSurvey™ on several computers running on the same LAN (Local Area Network).



Activation License Request

Please fill in your details to send a request:

Name: John Smith

Company Name: BADGER Ltd

Email: John.Smith@Badger.com

Telephone: 723-234-789

License Type: Trial Full Network

Cancel Send Request

Figure 5: DatuSurvey™ Trial License Request Dialog Box



Activation License Request

Please fill in your details to send a request:

Name: John Smith

Company Name: BADGER Ltd

Email: John.Smith@Badger.com

Telephone: 1723234789

License Type: Trial Full Network

License ID: DAT12-0401-2015-001

Cancel Send Request

Figure 6: DatuSurvey™ Full License Request Dialog Box



Figure 7: DatuSurvey™ Network License Request Dialog Box

5. You will receive your **license activation file (V2C file)** by email. This may take up to one business day.
6. Upon receiving the V2C, save it and when DatuSurvey™ starts, the “DatuSurvey™ Activation License” window (Figure 4) is displayed again. Click on **Load Activation File**.
7. Browse to the location of the V2C license activation file and click on the file. That completes the activation process.

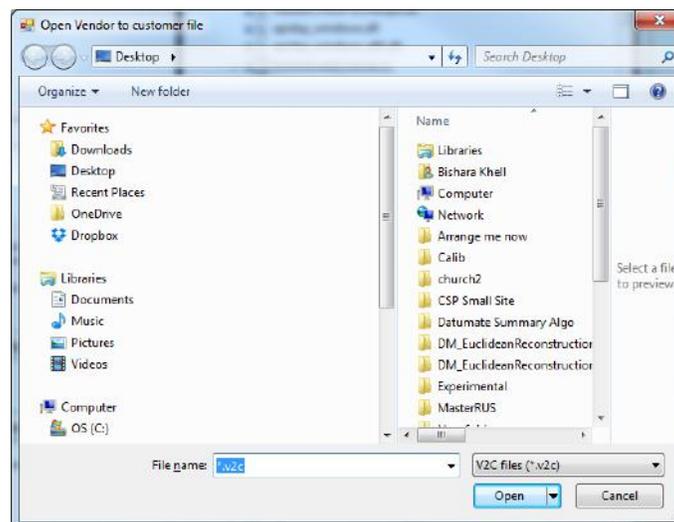


Figure 8: Selecting the Licensing File

8. If you have purchased a Network License, you can manage the number of available concurrent DatuSurvey™ licenses by adding or removing LicIDs in the “Activation License Request” form (Figure 4).

3.5 Reinstalling DatuSurvey™

You may reinstall DatuSurvey™ on the same computer any number of times. The installation process is identical to the initial installation process, and no activation is required.

However, if any hardware changes have been made on that PC, such as CPU or hard disk upgrades, you may need to re-activate the software license. The re-activate process is similar that of transferring DatuSurvey™ to a different computer (refer to Section 3.6.)

3.6 Transferring DatuSurvey™ to a Different Computer

Each regular software license allows you to install the software on a single computer. You may transfer the software from one computer to another computer by contacting Datumate support in order to deactivate the original license and activate a new license on the new computer.

3.7 Upgrading DatuSurvey™

Datumate periodically releases software updates for DatuSurvey™. These updates include new functionality, compatibility to new operating system versions, bug fixes, and more. These updates are available for customers who are registered with Datumate’s Annual Support and Update Program.

If you are eligible for software updates, it is highly recommended to install them upon their release by Datumate. Upon opening, the software will automatically check the availability of new versions and, if available, will notify the user about new version availability. Alternatively, to check for new software versions, click **Help** in the main menu and click **Check for Updates**.



Checking for the availability of new versions requires Internet connectivity to Datumate’s website www.datumate.com. Please make sure you have proper Internet connectivity, and verify that your local Firewall does not block HTTP connection with Datumate’s website.

3.8 Updating License Key

If you have a very an old version of DatuSurvey™ you may at some point be requested to change you license ID. To do this you will need to contact your local distributor or Datumate, who will supply a License ID and a License Key by e-mail. To update the license ID select the menu option Help/Update License ID which will show the following dialog.

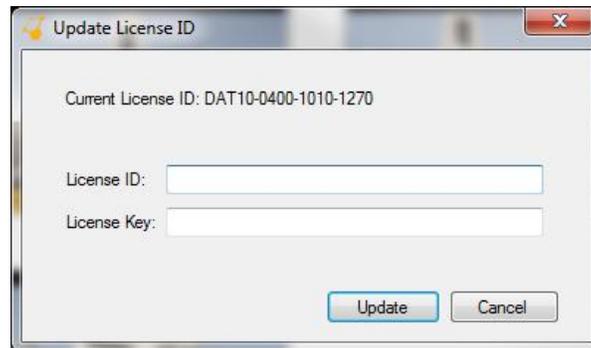


Figure 9 - Updating License ID

Simply copy and paste both License ID and License Key in the correct fields and press update.

4 Field Work: Taking Photos and Measuring Control Points

4.1 Choosing your Camera and Lens

The following guidelines and recommendations will help you choose an optimal camera and lens for surveying work:

Use a high-resolution camera. It is recommended to use a camera with at least an 18-megapixel resolution. Typically, an 18-megapixel camera provides a 1 to 2 centimeter (3 to 6 hundredth of a foot) measurement accuracy to a distance of about 100 to 150 meters (110 to 160 yards, 330 to 480 feet).



DatuSurvey™ does not support images taken with cameras having sensors greater than 36-megapixel because the application may not be able to contend with the resulting file size

- **Use a camera with a large CCD/CMOS sensor.** It is recommended to use a camera with a CCD/CMOS sensor size larger than 100mm².

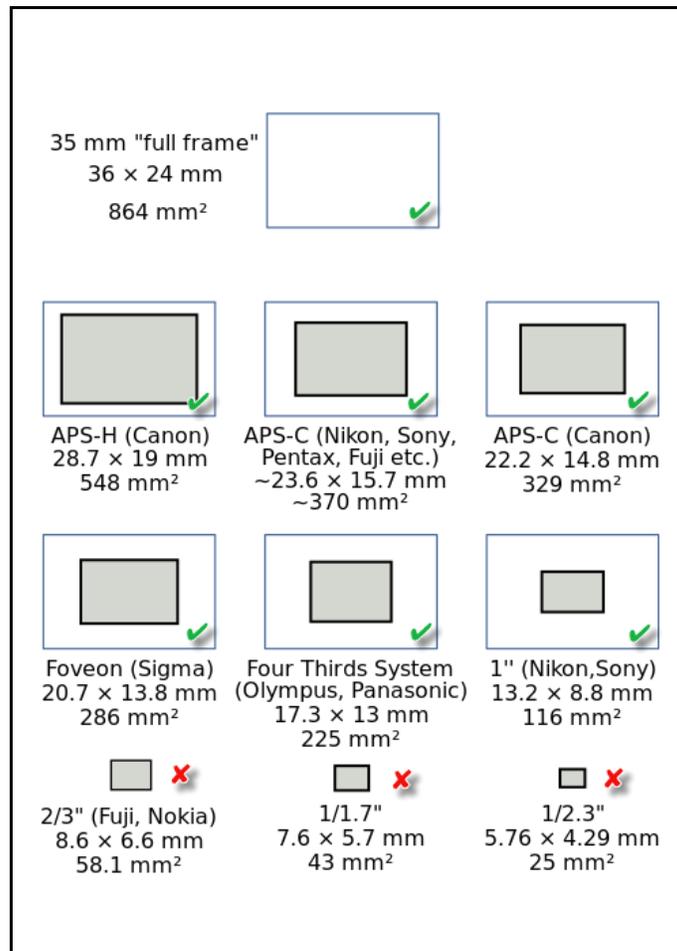


Figure 10: Common CCD/CMOS Sensor Sizes used by Digital Cameras

 A camera with lower resolution and smaller sensor size can be used but this will degrade the measurement accuracy and the performance of the automatic algorithms of the software. For example, an 8-megapixel compact or smartphone camera with a 40mm² sensor size will provide a measurement accuracy of 1 to 2 centimeter (3 to 6 hundredth of a foot) at a distance of only 30 to 40 meters (32 to 43 yards, 96 to 129 feet).

- **Use a lightweight camera with Wi-Fi connectivity.** It is recommended to use a camera with body weight lower than 300 grams and Wi-Fi connectivity. This facilitates easier installation and operation of the camera on telescopic poles or small UAVs.
- **Use a wide-angle lens.** It is recommended to use a wide-angle lens with fixed focal length between 8 and 16 mm. The wide angle provides a sufficiently broad field of view (FOV) to capture a spacious area when in close proximity to the target. This enhances the quality of measurements for images.

- **Use a lens with a fixed focal length.** DatuSurvey™ requires that the camera's focal length will not change after the calibration of the camera and during the photographing of the survey area. Thus, it is strongly recommended to use a fixed focal length lens, i.e., a lens without optical zoom.
- The recommended camera types that are particularly suitable for the requirements mentioned above are **lightweight mirror-less digital cameras with interchangeable lenses and Wi-Fi connectivity.** As of March 2016, the list of recommended camera models includes:
 - **Sony A7R with full frame 35mm lens** (36.4 megapixel, CMOS Sensor, 35mm format sensor = 861.6 mm² sensor size, Wi-Fi connectivity, body weight 465 g) + Samsung 35 mm fixed lens.
 - **Sony Alpha ILCE-A6000** (24 megapixel, mirror-less, interchangeable lens, APS-C format sensor = 370 mm² sensor size, Wi-Fi connectivity, body weight 285 g) + Sony 16 mm fixed lens.
 - **Samsung NX Mini** (21 megapixel, mirror-less, interchangeable lens, 1" BSI format sensor = 116 mm² sensor size, Wi-Fi connectivity, body weight 158 g) + Samsung 9 mm fixed lens.
 - **DJI Phantom 3- Professional and DJI Phantom 4** (12 megapixels, 35mm format sensor, 20 mm fixed lens, FOV=94°).
 - **DJI Inspire 1Pro** (X5 - 16 megapixels, 15 mm fixed lens, FOV =72°).

4.2 Photographing the Survey Area

The following guidelines and best practices will help you photograph the survey area in an optimal way. Here you will find some general recommendations, recommendations for taking oblique images, and recommendations for taking vertical images.

General Recommendations:

- **Use a drone to take images using Datumate's automatic flight planner DatuFly™.** This will increase the probability that images will be stitched into one cluster.
- **Make sure your images cover at least 4 GCP's.** Even though the minimum mathematical requirement to build a model is 3 GCP's, it is strongly recommended to use at least 4 GCP's, so when control points are used, make sure that your images cover at least 4 Ground Control point and each one appears in at least 3 images.
- **Set your camera to maximum resolution.** Note that some camera models are preset to photograph in a resolution lower than their maximum resolution. Make sure your camera is set to the maximum resolution available.
- **Make sure camera is set to save the GPS location of the images.** This is a must for vertical images and recommended for oblique images.
- **Take your images in good and consistent lighting conditions.** Take all images in similar lighting conditions, preferably at the same time of the day. Avoid photographing the survey area during different times of the day. This will minimize changes in shadings and lighting conditions that may degrade the performance of the automatic image processing algorithms employed by DatuSurvey™. Do not take or use images of dark areas.

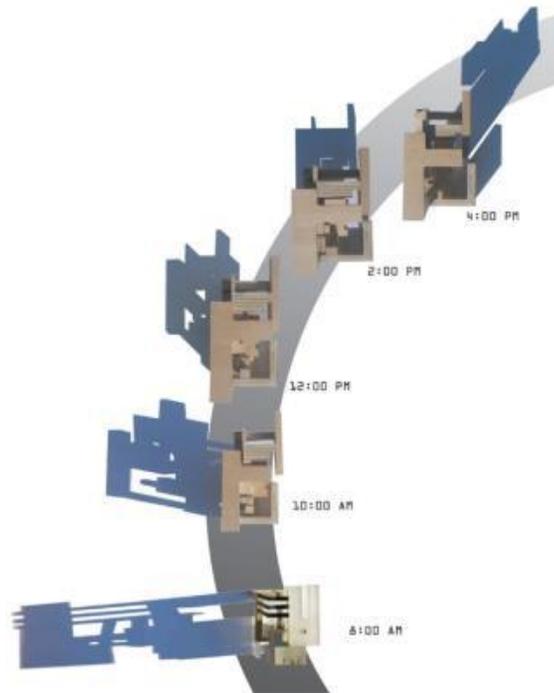


Figure 11: Examples of Changes in Shadings and Lighting Conditions

- **If you use a zoom lens, do not change its settings while taking images.** Modifying the zoom setting changes a camera's calibration parameters. Thus, use a lens with fixed focal length rather than a lens with zoom capabilities. However, if you do use a zoom lens, set it to the widest field-of-view and do not change this setting when photographing.

Recommendations for oblique images:

Oblique images will be used to survey small areas, intersections or façades. Normally such project are considered small projects and the number of images taken for such project is not large.

- **Assure that every point you want to measure appears in at least three images which have been taken at different positions.** The key principles of photographing the survey area is that any point you want to measure should appear in at least three images from different viewing angles. The best measurement accuracy will be attained if the maximum angle of photography between the images will be 90°.

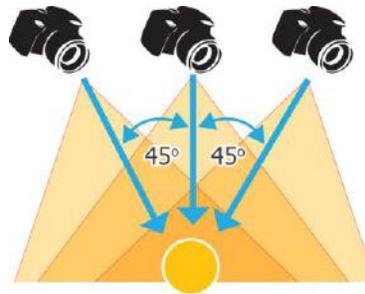


Figure 12: Achieving Optimal Measurement Accuracy

- Elevate the camera above ground level to minimize foreground obstructions hiding features surveyed.** Elevating your camera above ground level is a key success factor for employing close-range photogrammetry. Elevating the camera above ground level helps avoiding low-lying foreground obstructions such as fences, cars, and near ground vegetation, thus generating images of the survey area with minimal obstructions. Moreover, some techniques used to elevate the camera above ground level, such as installing the camera onboard a small quadcopter, allow a much faster process of photographing the surveyed area, thus significantly enhancing fieldwork productivity.

Take photographs from an elevated vantage point, such as from the rear of a vehicle or from a building overlooking the survey area, or use a monopod to raise the camera several meters above ground level. Lightweight, portable telescopic poles intended for photography, allow taking pictures from 6 to 10 meters (20 to 30 feet) above ground level while remotely controlling the camera using the Wi-Fi function on a smartphone or a tablet. Another highly effective method to overcome obstructions is the use of small UAV copters. A UAV copter, flying at an altitude of 17 to 23 meters (50 to 70 feet), easily bypasses low-lying obstructions while the wide-angle lens of the camera (smaller than 16mm focal length) provides a very large field-of-view.



Figure 13: Overcoming Low-Lying Obstructions

- Modify the camera’s elevation for each image.** This will ensure optimal measurement accuracy.



Figure 14: Modifying the Camera’s Elevation

- **Take images only in landscape format.** DatuSurvey™ does not support images in portrait format. If your camera is equipped with *Auto Rotate* functionality, set it to “Off” so that all images remain in landscape format.

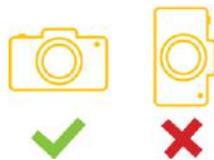


Figure 15: Correct and Incorrect Camera Positioning

- **Take a large number of images of the survey area from different viewing angles.** The more images from different viewing angles you take of the survey area, the better the automatic algorithms will perform in associating the images and detecting new points. To achieve optimal results, take at least 20 to 30 consecutive images of your survey area from different viewing angles. It is possible to work with up to 200 images to cover larger area.
- **Maintain a consecutive order of the images.** While photographing the survey area, maintain a consecutive order of the images. This will ensure optimal performance of the automatic algorithms for associating images and detecting new points. If you do not do this you will need to manually order the images after loading them into the software which may be a lengthy process.

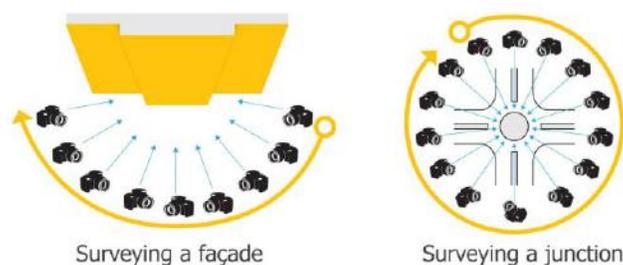
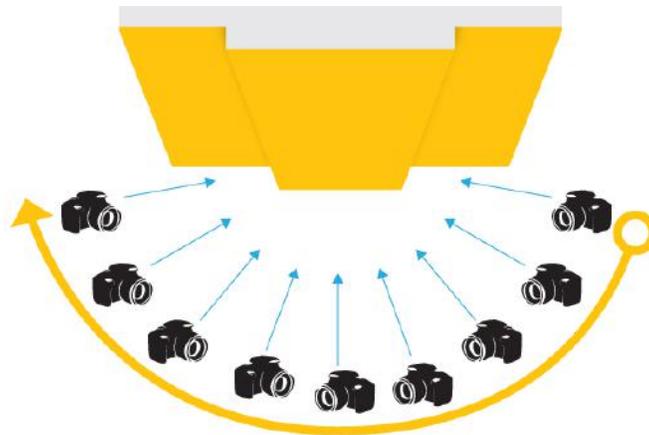


Figure 16: Maintaining a Consecutive Order of Images

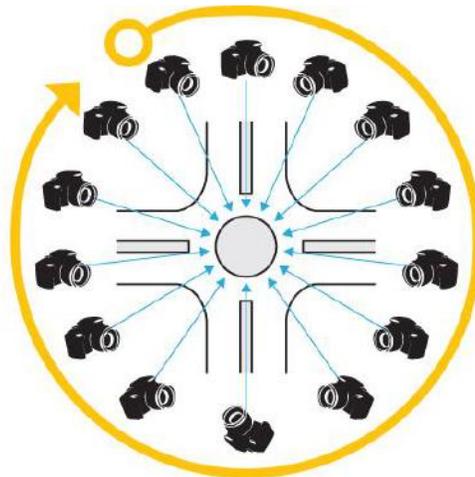
- **Surveying an object (façade, landmark, etc.).** To survey an object, such as a façade or landmark, take 20 to 30 consecutive images as you walk along the object. Take a new image every few meters while keeping the camera centered on the center of the object. Elevate the camera above ground level to minimize obstructions, and slightly modify the elevation of your camera between images.



Surveying a façade

Figure 17: Surveying an Object

- **Surveying an area (intersection, bridge, etc.).** To survey an area such as an intersection or bridge, take 20 to 30 consecutive images of the area's perimeter. Take a new image every few meters while keeping your camera centered on the center of the surveyed area. Elevate the camera above ground level to minimize obstructions, and slightly modify the elevation of your camera between images.



Surveying a junction

Figure 18: Surveying an Area

- **Recommendations for vertical images:**

Vertical images will be used to survey large scale areas, stock piles, and long roads. Normally such project are considered small projects and the number of images taken for such project is large. All projects that fall under this category will be photographed using a slalom path, meaning going back and forth taking images to cover the whole area. All images will be taken along the long flight paths.

- **Maintain proper overlap.** It is recommended to maintain at least 75% front overlap and 60% side overlap.
- **Surveying a long road.** Defining the slalom flight trajectory over a road can be done in one of two ways, flying the long paths parallel to the road or across the road. Flying parallel to the road will mean taking less images, but it might have traffic problems if one or more cars are travelling with the drone, which means they will appear in many images. While flying across the road will mean more images, but traffic is easier to filter out.
- **Keep projects manageable.** To keep projects manageable divide them into sections or area. For example, divide roads into sections of about 1500 meters (one mile) in length each. Or if you have many stock piles, cover each or every few stock piles separately. Pay attention that in this version of DatuSurvey™ up to 200 images may be linked in one job, so you may want to take this in consideration when you divide the area.

4.3 Geo-Ref / Scale

You can choose between **Geo-Ref.**, **Scale**, or **Rough Scale** as the referencing system for a specific job cluster.

By selecting **Geo-Ref** you need control point measurements in the field, then you'll need to mark them on images, this will add position, orientation, and scaling to your output or 3D model.

While **Scale** selection will allow you to add scaling-only to your output or 3D model, without any special surveying tools, scaling-only is achieved by measuring 2 slope distances in the field, then mark each distance on 2 images each, it could be very useful for volume calculation since it requires scaling only and there's no need for position or orientation to calculate volume. Alternatively it is possible to work without geo-referencing or scaling by selecting the "Rough Scale" option. This will basically allow you to start working on the model, while ground control points or distances are being measured. In this option you will need to mark one rough estimate of a distance on 2 images. This option can also be used for quickly generating views for different purposes such as presentations, where measurements are not necessary. In both scale and rough scale mode you will also be required to set the gravity direction. Finally, **Geo-Tag** option will allow you to use the image geo tagging data to set your scale and gravity options. This mode is also approximate and similar to the rough scale option.



4.3.1 Measuring Control Points for Image Geo-Referencing

The following guidelines and best practices will help you measure your control points in the survey area in an optimal way:

- **Measure at least four control points in the survey area of a small project.** At the minimum, each control point should appear in three of the images of the survey area, which should be photographed from different angles or vertical locations, as close as possible to 90°. **It is very strongly recommended to measure and mark 4 or more control points.** Measuring and marking more control points in more images will improve the resiliency of the geo-referencing process, assuming the measurement of control points is accurate itself. You may measure point coordinates in either a local or a national grid. The software will allow you to work with 3 control points marked in two images each.

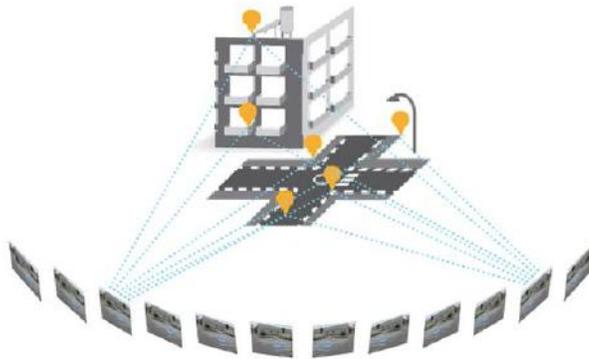


Figure 19: Measure at Least Three Control Points

- **Measure at least one control point every 40-50 meters on each side in elongated survey areas such as roads.** Also try to measure points at different elevations if possible.
- **Measure as many control points as possible of large scale areas.** It is very important that you cover all safely reachable areas, especially on the perimeter of the area of interest.
- **Choose clearly defined control points.** Choose control points that have high contrast with the area around it and will be unambiguously and accurately identifiable in the images. Use available landmarks or deploy your own prominent objects in the survey area if no appropriate landmarks are available. Good choices for control points are pointed shapes on flat surfaces such street paint marks, or corners of paint, tile, or stone patterns on building walls. Corners of a building or tips of objects are good only for confirming the other control points. Avoid using extended objects as control points as well.

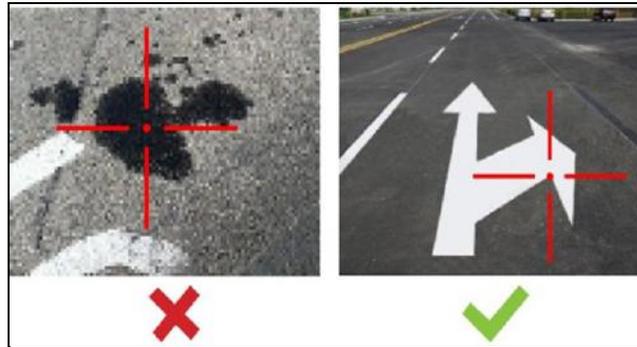


Figure 20: Choose Clearly Defined Control Points

- **Avoid measuring points on slanted surfaces.** This is specifically important when using a Total Station with in reflector-less mode.
- **Accurately measure the position and elevation of the control points.** Carefully measure the position and elevation of control points with an accuracy of better than 2 cm (0.79 inch). Make sure you mark the exact and not the approximate location of the measured points on the sketch. Remember, the accuracy of measuring the position and elevation of control points sets the accuracy baseline for all the measurements and drawings related to the images.
- **Scatter the control points in the survey area.** To attain maximum accuracy, scatter your control points across the survey area relative to breadth, depth, and height. Select control points on the perimeter of the survey area, so that measurements in the survey area are interpolated rather than extrapolated. Make sure they are well scattered in the survey area.
- **Choose control points on more than one plane.** To attain maximum accuracy, select points at both ground level and elevated positions.

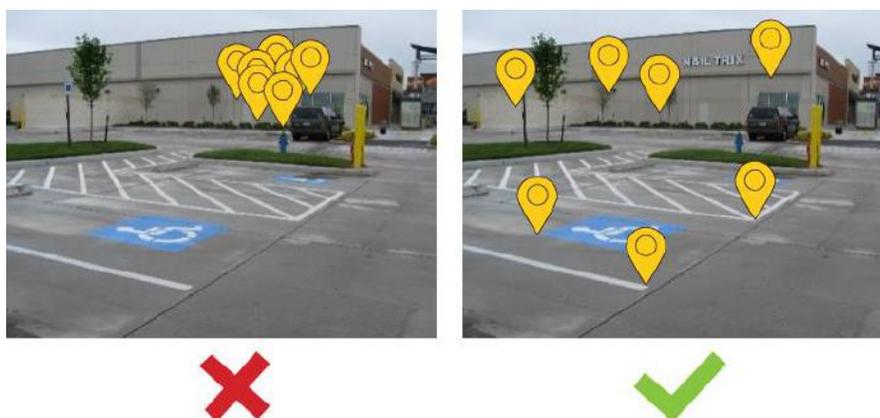


Figure 21: Choose Well-scattered Control Points



Make sure your control points are not all located on the same plane, such as at ground level or on a vertical flat façade. Choosing control points that lie all on the same plane will degrade the accuracy of the geo-referencing of the photogrammetric model.



Figure 22: Control Points Measured in Many Planes

4.3.2 Measuring Distances for Image Scaling

The following guidelines and best practices will help you measure distances in the survey area in an optimal way:

- **Measure at least two distances in the survey area** - At the minimum, two distances should appear in two of the images of the survey area, which should be photographed from different angles, as close as possible to 90°. Measuring and marking more distances in more images will improve the resiliency of the scaling process.
- **Choose clearly defined distances** - Choose distances that will be unambiguously and accurately identifiable in the images. Good choices for distances are distances between pointed objects such as the corners of a building or street marks.
- **Accurately measure distances** - Carefully measure the distances with an accuracy of better than 1 cm (0.4 inch). Remember, the accuracy of measuring the distances sets the accuracy baseline for all the measurements and drawings related to the images.
- **Choose distances on more than one plane** - To attain maximum accuracy, select distances at both ground level and elevated positions.

5 Calibrating Your Camera

Before processing your images with DatuSurvey™, it is important that you calibrate your camera, i.e., calculate the internal parameters of your camera and lens system. This includes the camera and lens focal length and radial distortions. DatuSurvey™ takes the initial values of these parameters, and readjusts them to compensate for any changes in the camera's internal parameters due to the automatic focus of the lens or environmental conditions such as ambient temperature changes.

Note that the internal calibration parameters are different for different camera bodies and lenses, thus the calibration procedure should be repeated whenever a new camera body or lens is used. DatuSurvey™ will save the calibration parameters of multiple cameras and lenses that you use. Also note that the calibration parameters change when using optical zoom, and thus it is recommended to use lenses with a fixed focal length, i.e., not equipped with optical zoom.



Replacing your lens or using a new camera body requires recalibrating the camera and lens and saving the new calibration parameters in DatuSurvey™.



As part of the installation process, predefined camera calibration parameters are available for some cameras and if you intend to use one of these cameras, you can save time by selecting one of the pre-calibrated calibrations. But if, in spite of the fact that you have used our best practices, the job results are not suitable, you may need to calibrate your camera rather than rely on the pre-calibrated calibrations. Indications for that might be multiple clusters or poor accuracy.

5.1 Calibration Procedure

The calibration process of the camera and lens includes the following steps:

- Photographing the survey area or alternatively using a subset of images of the job that will be processed. See section 5.2 for best practice for taking or selecting images to be used in field calibration.

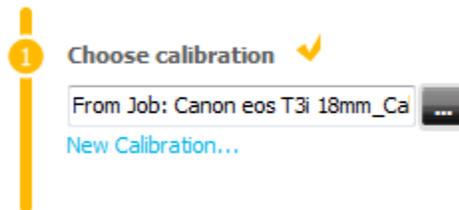


It is always possible to send the images to our support team, who can create the calibration file for you. Then you can simply import it into your library and use it. To do so send the images to support@datumate.com.

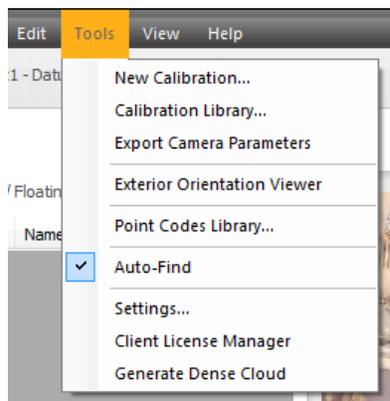
- Loading images to DatuSurvey™
- Getting initial camera parameters from one of the available sources including automatic extraction of internal parameters from images
- Running the calibration process and saving this new calibration
- Linking the images using the newly generated calibration file
- Adding Floating Control Points in the Geo-Ref/Scale stage and using the Apply function to get an adjusted calibration
- And, finally saving the final adjusted calibration to the calibration library

To calibrate your camera, simply follow these simple steps:

1. Click 'New Calibration...' from "Images" tab



Or from **Main Menu -> Tools -> New Calibration...**



2. Select one of the available sources for getting the initial camera calibration values in order to be able to run the calibration

New Calibration

Create New Calibration

Get initial calibration values from one of the following sources:

- Calibration Library: Select Calibration...
- EXIF metadata
- Saved Job: no file selected: Select Job...
- Custom

Some details/parameters were auto detected from images (EXIF metadata)

Camera and Lens Details

Camera Manufacturer: Example: Canon
 Camera Model: Example: EOS ID
 Lens Model: Example: EF 24mm f/1.8
 Focal Length: mm
 Resolution: Example: 6000x4000

Internal Camera Parameters (Initial)

Focal Length: Calculate px Radial distortion parameter (K3):
 E Coordinate of principal point (E0): px Tangential distortion parameter (Tau1):
 N Coordinate of principal point (N0): px Tangential distortion parameter (Tau2):
 Radial distortion parameter (K1): Pixel Aspect Ratio:
 Radial distortion parameter (K2): Pixel Skewness:

- Adjust camera and lens parameters if needed, hit "Calibrate", and wait for the calibration process to end

New Calibration

Create New Calibration

Get initial calibration values from one of the following sources:

- Calibration Library: Select Calibration...
- EXIF metadata
- Saved Job: no file selected: Select Job...
- Custom

Calibration Successful

Camera and Lens Details

Camera Manufacturer: Example: Canon
 Camera Model: Example: EOS ID
 Lens Model: Example: EF 24mm f/1.8
 Focal Length: mm
 Resolution: Example: 6000x4000

Internal Camera Parameters (Final)

Focal Length: Calculate px Radial distortion parameter (K3):
 E Coordinate of principal point (E0): px Tangential distortion parameter (Tau1):
 N Coordinate of principal point (N0): px Tangential distortion parameter (Tau2):
 Radial distortion parameter (K1): Pixel Aspect Ratio:
 Radial distortion parameter (K2): Pixel Skewness:



If an existing calibration is selected from the library or from an existing job, mismatches may occur due to incompatibilities between current images selected for calibration and the calibration file. Depending on the degree of divergence, select to continue or perform a new selection.



When data is extracted from the EXIF metadata, the Focal Length [px] may not be identified during the process. You must manually fill in the Sensor Width if it is not there. The Sensor Width data can be retrieved from the camera maker or any professional camera web site, such as DPREVIEW or from Wikipedia.



If parameters are missing or there is a conflict with the EXIF data, you will be requested to select the “Custom” option to edit various fields.

4. Click ‘Finish’ and the Calibration Name window shown below will allow you to confirm or modify the automatically generated name of your new calibration and optionally uncheck/check the option to add it to the calibration library.

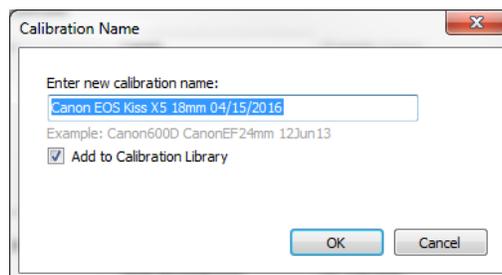
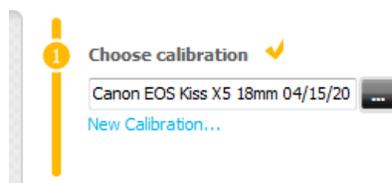


Figure 23 - Calibration Name Window

The new calibration will automatically be selected in the Choose Calibration option as shown below



5. Click the 'Link' button to link the images. Once the link process is done, you will see the link result in the right panel as shown below. If the image set was selected carefully and according to the best practice, only one cluster will be generated.

Images are linked in 1 cluster

Cluster	#Images
A	13

6. Click 'Next', or alternatively click on the Geo-Ref/Scale tab name, to move to the Geo-Ref/Scale stage. If more than one cluster was generated you will need to select only one of the clusters to continue the calibration process with. The final goal in this stage is to add Floating Control Points and press the "Apply" button. This will generate an adjusted calibration, which will be the calibration that we need to save (export) and use.
7. Select the cluster you want to work with if more than one exists.
8. Use any of the available model options, Geo-Ref, Scale, or Rough Scale, as long as you have enough information to satisfy its minimal requirements. For example, keep the cluster model as a Rough Scale model, and add one Rough Scale and gravity to satisfy the minimal requirements of a Rough Scale model. Refer to section 6.4.3 on how to do so.



It is preferable to work in Geo-Ref or Scale mode, but if you use the Rough Scale mode, make sure the distance you use is reasonably close to reality. The Geo-Tag option is also a good replacement for the "Rough Scale" mode when the geo-tagging information is available on the images.

9. Add additional Floating Control Points to better adhere images to each other. Refer to section 6.4.10 on how to add FCP's. The more FCP's you add the better your calibration will be.
10. Press the "Apply" button, review residuals, and make adjustments following the standard work process till you are satisfied with the results. See example below.



11. Select the menu option “Tools/Export Camera Parameters” as shown below. This will open a window that will allow you to select the cluster of which the adjusted calibration will be exported. Exported calibration can be imported into the calibration library at any time using the import function available in the Calibration Library window.

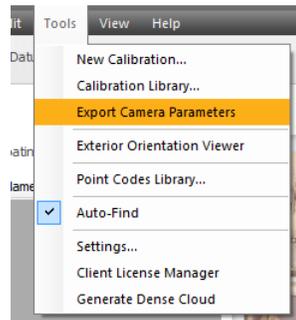


Figure 24 - Exporting Adjusted Camera Calibration

5.2 Field Calibration Image Set

This section describes the best of practice of taking or selecting images for the sake of camera field calibration.

- Refer to section 4.2 on best practice for taking images for jobs where illustrations are also available.

- DO NOT use images with sky, water, or flat sand with no features.
- DO NOT use images with a lot of glass showing reflections.
- DO NOT use images with moving objects in them, such as traffic.

For UAV Cameras:

- Take 18-30 images in a circular mode with equal spacing between them, taken from similar distances of about 15-20 meters.
- All images should be pointing to a center point, with minimum 70% overlap between them.
- Take oblique image at 45 degrees.
- Images should have low frequency texture such as a stock pile, a rock, or an intersection.

For Ground Cameras:

- Take 12-18 images in an arc mode with equal spacing between them, taken from similar distances of about 15-20 meters.
- Do not use images that were taken in a straight line.
- All images should be pointing to a center point, with minimum 70% overlap between them.
- Images should have low frequency texture.

5.3 Calibration Library

Click **Tools > Calibration Library...** in the main menu of DatuSurvey™.

Click **Add, Edit, Delete, Import** or **Export** to modify camera calibration files.

- **Add** allows manually adding a new camera calibration file to the Calibration Library.
- **Edit** permits modifying the calibration parameters, to incorporate external parameters or to change the MSE.
- **Delete** permits removing a specific camera calibration from the Calibration Library.
- **Import** permits importing a camera calibration file into the Calibration Library.
- **Export** permits exporting the selected camera calibration file.

Calibration Library

Calibration Name	Camera Model	Camera Manufacturer	Lens Model	Focal Length [mm]	Focal Length [px]	I0 [px]	I0 [px]	I0 [px]
Canon EOS Kiss ...	Canon EOS Kiss X5	Canon	Canon EF-S 18-...	18	4209.08068...	2594.46165...	1763	
DJI FC300X 3.6...	FC300X	DJI	UNKNOWN	3.6	2341.92133...	1999.20358...	1473	
DJI FC300X 3.6...	FC300X	DJI	UNKNOWN	3.6	2341.92133...	1999.20358...	1473	
DJI FC300X 3.6...	FC300X	DJI	UNKNOWN	3.6	2341.92133...	1999.20358...	1473	
DM_Canon_EOS...	Canon EOS Kiss X5	Canon	Canon EF-S 18-...	18	4289.951	2596.066	1738	
Canon EOS Kiss ...	Canon EOS Kiss X5	Canon	Canon EF-S 18-...	18	4209.08068...	2594.46165...	1763	
DJI FC300X 3.6...	FC300X	DJI	UNKNOWN	3.6	2333.91607...	1998.58454...	1466	
Canon EOS Kiss ...	Canon EOS Kiss X5	Canon	Canon EF-S 18-...	18	4209.08068...	2594.46165...	1763	
Canon EOS Kiss ...	Canon EOS Kiss X5	Canon	Canon EF-S 18-...	18	4209.08068...	2594.46165...	1763	
Canon EOS Kiss ...	Canon EOS Kiss X5	Canon	Canon EF-S 18-...	18	4209.08068...	2594.46165...	1763	
SONY ILCE_600...	ILCE-6000	SONY	E-Mount, T-Mou...	16	4088.10619...	2968.17624...	1953	
SONY ILCE_600...	ILCE-6000	SONY	E-Mount, T-Mou...	16	4076.82962...	3001.57254...	1973	
DM_Sony_A600...	ILCE-6000	SONY	E-Mount, T-Mou...	16	4072.524	2976.275	1913	
DM_Phantom_3...	FC300X	DJI	UNKNOWN	3.6	2302.693	1989.16	1513	
DM_Sony_A7R...	ILCE-7R	SONY	E-Mount, T-Mou...	35	7409.489	3631.872	2496	

Buttons: Add, Edit, Delete, Import, Export, OK, Cancel

Figure 25: Camera Calibration Library



As part of the installation process, predefined camera calibration parameters are available for specific cameras. The internal calibration parameters vary for each camera. If the job results are not suitable when using pre-calibrated camera you may need to calibrate your own camera rather than use the pre-calibrated camera.

6 Working with DatuSurvey™

6.1 Starting DatuSurvey™ Application

The DatuSurvey™ application includes a series of opening screens which provide essential information about basic requirements and getting started.

1. If you do not want these pages to be displayed the next time the application is opened, unclick the “Show this at startup” radio button.

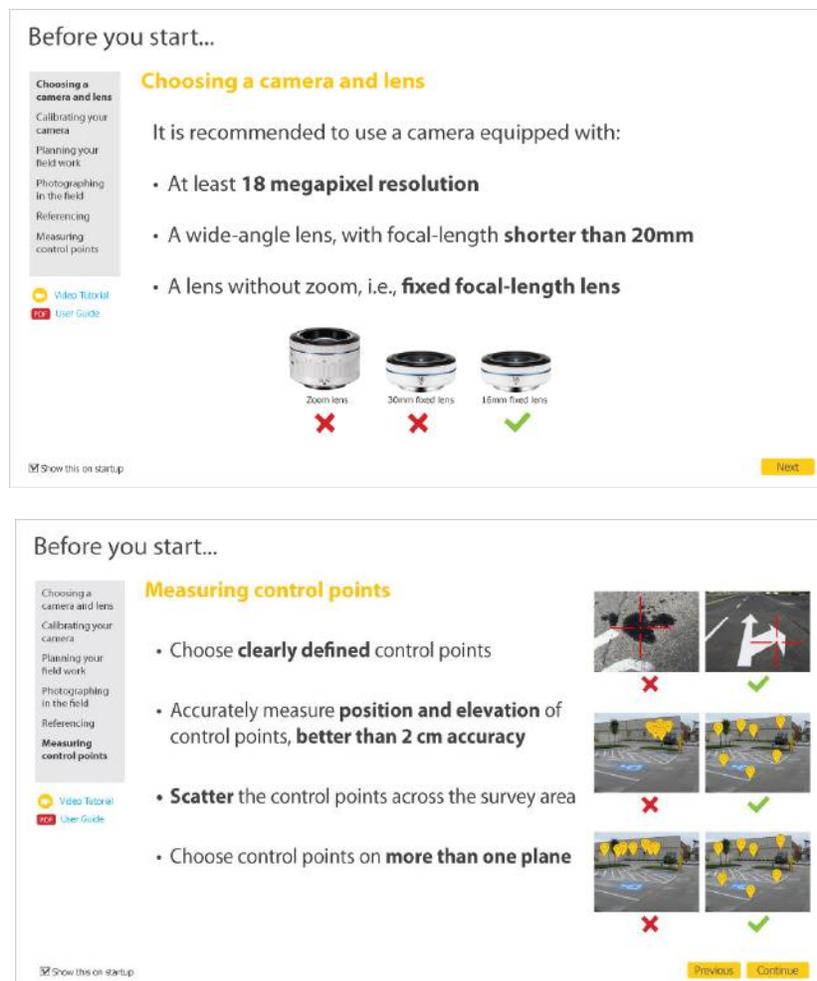


Figure 26: A Few of the Startup Windows

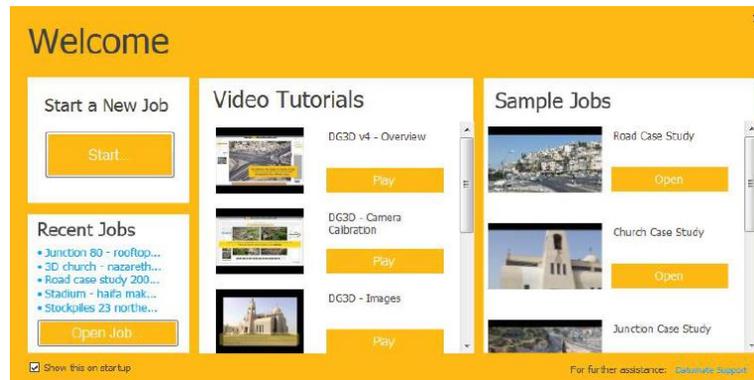


Figure 27: Welcome Screen

6.2 Working with Jobs

6.2.1 Opening a New Job

To begin working with DatuSurvey™ – with photographs and measurements of a new area – open a new job.



At any stage in working with DatuSurvey™ you can undo (Ctrl+Z) and redo (Ctrl+Y) most of the steps performed.

Once you have progressed to the next image or stage in the project, your work cannot be undone. Undo/Redo activities are per viewed-image or screen. If you move to another image, all actions which were “remembered” for Undo/Redo are lost.

1. Click **File > New Job** in the main menu of DatuSurvey™, or use the shortcut **Ctrl+N**.
2. Fill in the Job Name in the “Job Properties” dialog box. Use a standard naming convention that includes information such as the façade address, date of photograph, camera model and lens focal length, e.g.: **CityName_StreetName_Date_Canon600D_24mm**.
3. **Select the method of image taking.** When vertical is selected, and images have geo-tagging information, the link process will use the GPS position of the images to decide which images should be matched together. This means that images do not need to be ordered in a certain way for the link process to work.
4. Click **OK**.

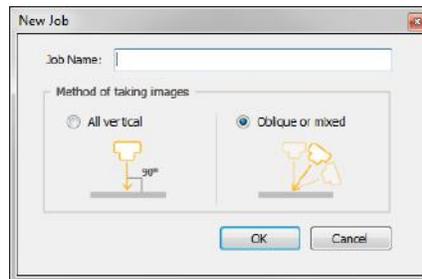


Figure 28: “New Job” Dialog Box

6.2.2 Opening an Existing Job

To open an existing job:

1. Click **File > Open Job** in the main menu of DatuSurvey™ or use the shortcut **Ctrl+O**.
2. Browse to the DatuSurvey™ Jobs folder, click the Jobs folder, select the Job file, and click **Open**. The images are displayed in the “Images” window (Figure 30).

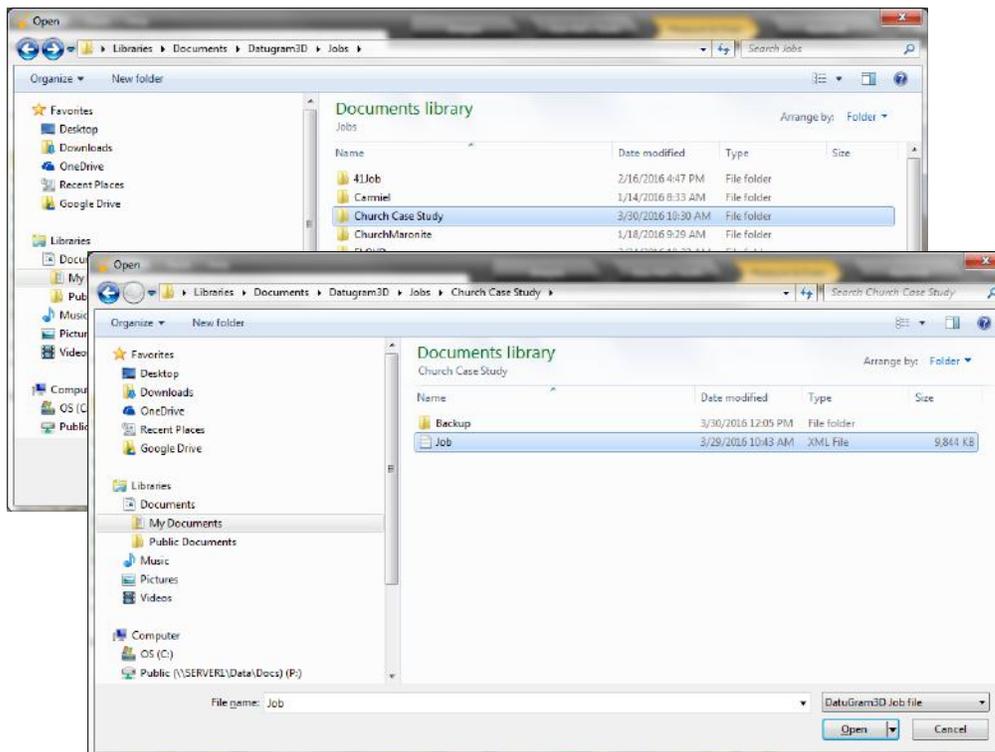


Figure 29: Opening a Job

3. If not previously selected, in the “Choose Calibration” box, select the appropriate camera calibration from the list of calibrated cameras. When possible the system may automatically select a suitable calibration based on the camera and lens model, and a notification will appear below the “Choose Calibration” drop down. Starting with DatuSurvey™ version 4.7.0

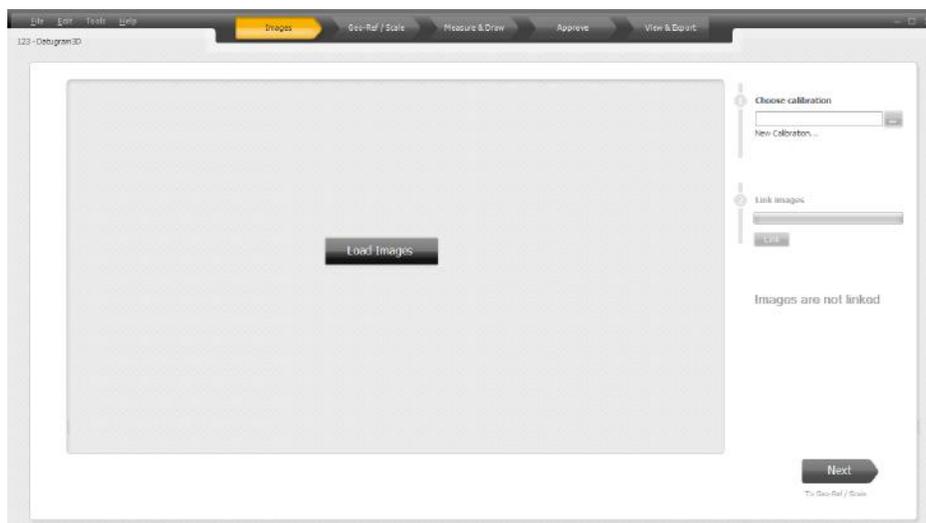
an improved camera calibration is used to generate a better model. Opening a job that was saved using a version prior to 5.0.0 does require the user to go into the calibration library and select a new camera calibration.

4. Optional: Click **New Calibration...** in order to create a new camera calibration (see chapter 5).
5. Optional: Click **Tools > Calibration Library...** in the main menu, in order to import new camera calibration to the list (see chapter 5).
6. If needed, click on the “Link” button to link the images. This may be required if you change the camera calibration or if the job was created using certain prior versions of DatuSurvey™. This step also may result in clustering images into groups that may need to be manually linked together. This is covered later in this chapter.
7. Click **Next**. The “Geo-Ref/Scale” window is displayed. After clicking **OK**, the “Images” window is displayed and performing job’s tasks can be initiated.

6.3 Step 1: Images – Loading Images, Camera Calibration, linking images and Managing of Clusters

There are five main steps to complete to handle a job from start to end. This section describes the first step followed by steps 2 to 5.

The first screen displayed after a job is opened is the “**Images**” window (Figure 30). In this window you handle the imagery of the job: loading images, removing images, calibrating the camera with which the images were taken, and geometrical linkage of the images.



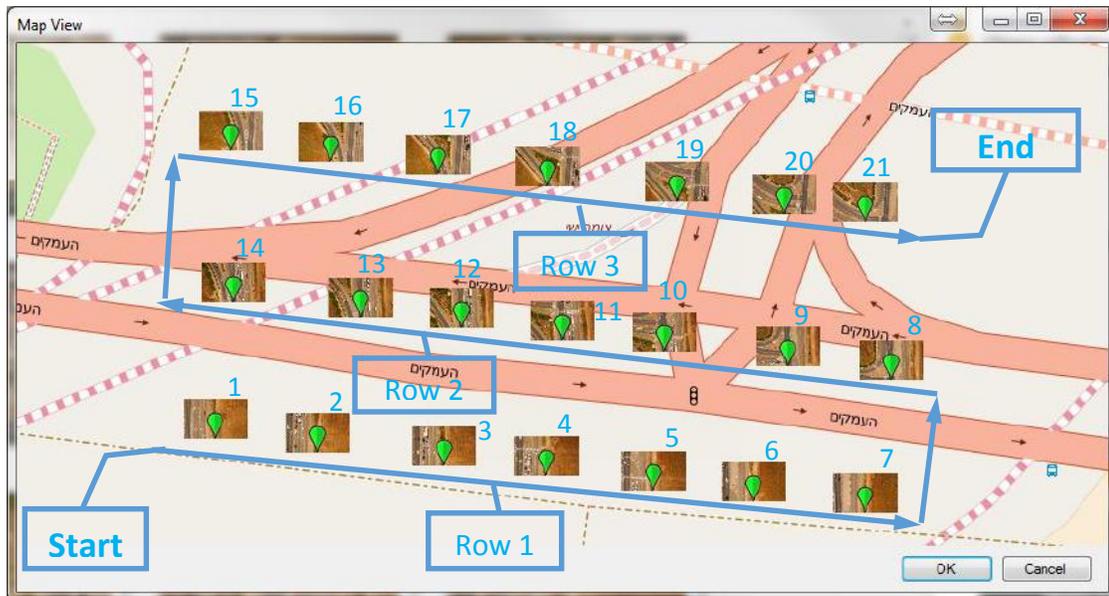


Figure 32 – Vertical image taking trajectory

The figure above shows a trajectory of vertical slalom image taking. As shown, the images were taken in 3 rows starting from image number 1 to image number 21. In each row there are 7 images. The direction images are taken goes with the direction of the flow of the trajectory. This means that the orientation of the images in each row is flipped 180 degrees from the prior row; meaning that Row 1 and Row 3 in the figure above were taken in the same orientation while Row 2 was taken in the opposite orientation. When this pattern is detected the system may ask the user to check if the orientation of each row is indeed opposite to the row before and after. If the automated flight planner DatuFly™ was used, it is assumed that this is true and the user will not need to check it, otherwise, the user will be asked to check the images and specify if this is true or not.

To check the image orientation a map view of the images will appear on the screen, as shown in the figure below. In the map view the trajectory of taking the images will be marked.

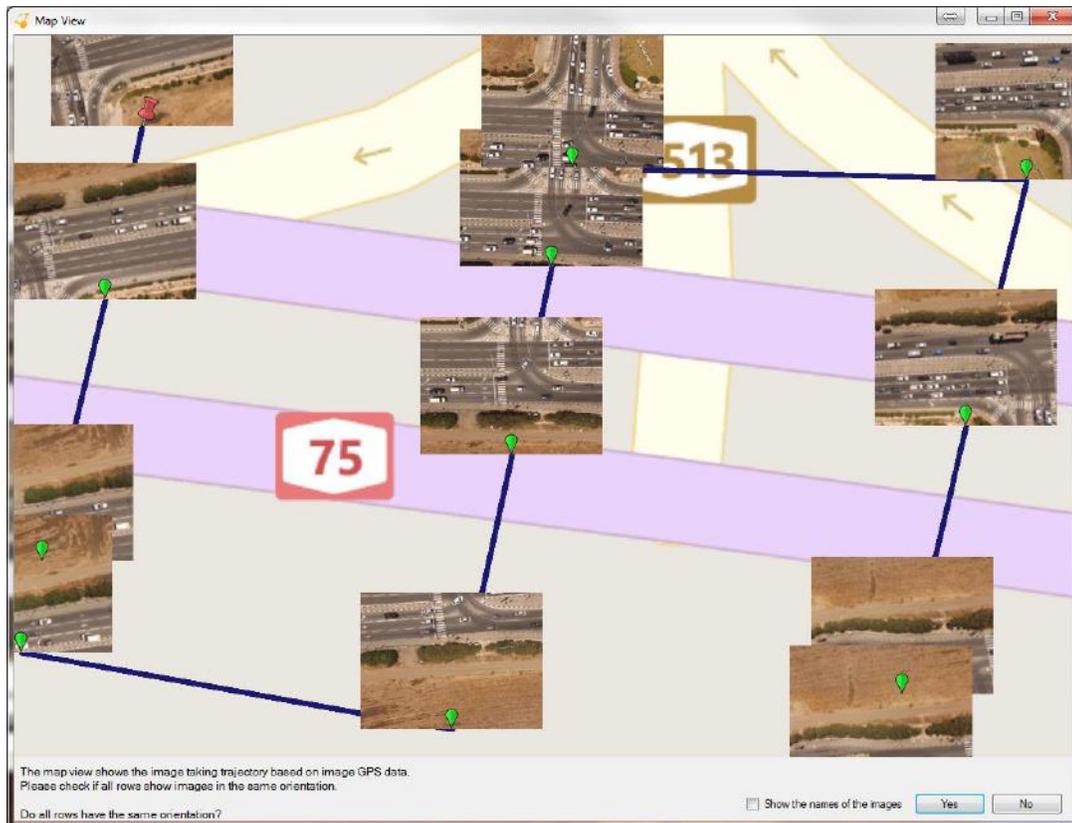


Figure 33 – Image Orientation Confirmation

Zoom into the map view and visually examine the images to see if all rows have the same orientation. Make sure you look at rows of images as taken in the image taking trajectory. Once done examining the images, answer the question in the bottom of the map view.



It is extremely important to review the images and answer the question properly. Each row of images should be compared to the row next to it. It is not necessary to compare all rows. It is enough to scan the rows and look for obvious features such as intersections, building, or street marks. If you see that images do have the same orientation, and not flipped click the “Yes” button, otherwise click “No”.



Once images are loaded, you may press on the “Map View” option “” shown at the top left corner of the window to see the locations of the images layed on top of a map as shown below. You have to have a proper internet connection to be able to see the map, otherwise the background or the display will be black.

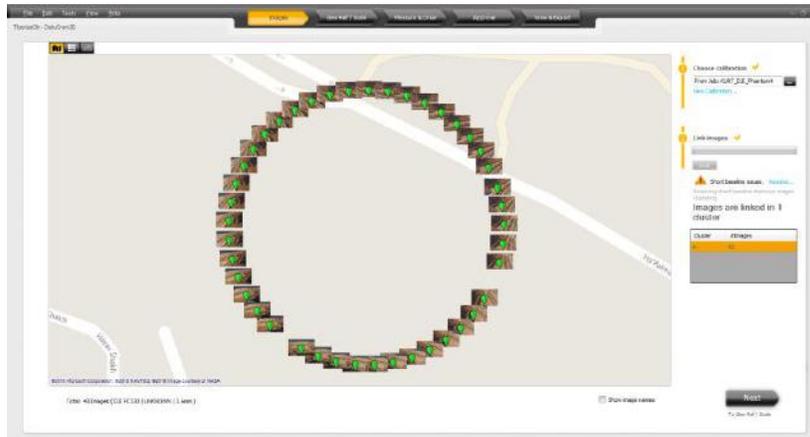


Figure 34 - Map view of Geo Tagged images

You may click on any image to open it in a new window. You may also right click to show additional options to delete one image or select images one at a time and then delete all selected images. Alternatively you may multi select several images using a standard mouse function. Images initially have a green marker, when selected they will have a yellow marker, and when deleted the marker becomes white and the image thumbnail disappears as shown in the figure below. Note the actual deletion of images from the job takes place only when you click OK and leave the Map View window.

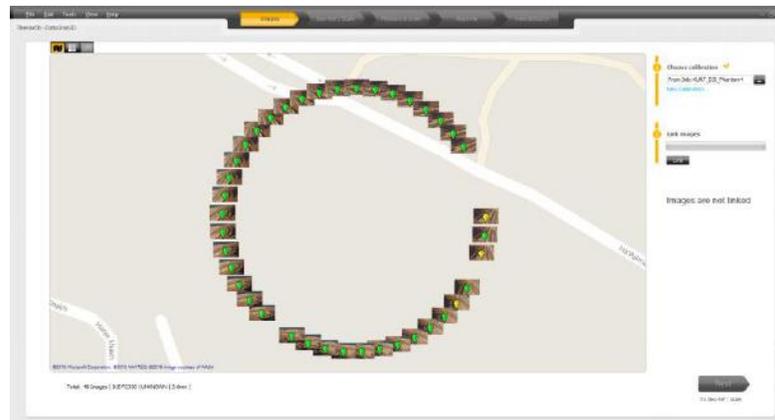


Figure 35 - Map View with selected images

2. **Choose Calibration** - If not automatically selected, select the appropriate camera calibration from the list of pre-calibrated cameras. If the camera in which images were taken, does not exist in the list, then the camera must be calibrated. Click **New Calibration...** in order to create a new camera calibration or click **Tools > New Calibration ...** in the main menu. (See Chapter 5).

3. Click **Link**. The images are automatically linked in clusters (groups of linked images), based on homological points.

If your images have GPS data the link process will be based on the GPS location of the images, hence there is no need to order images a certain way in the Images tab. While if no GPS data exist in on the images, then the link process will be based on the order of images in the Images tab.

6.3.1 Short Baseline issues

If the link process detects consecutive images with short baseline issues (images that are very similar), then the system will indicate that on the right side of the screen and will automatically open a window to allow resolving this issue by deleting part of the images. If you select not to resolve some or all of the issues, the message will stay on the screen with an option to press a “Resolve...” link to go back and resolve it. As shown below, the images are grouped and by default all marked for deletion except for the first one in each group. Once you press OK, marked images will be deleted and images will have to be linked again.

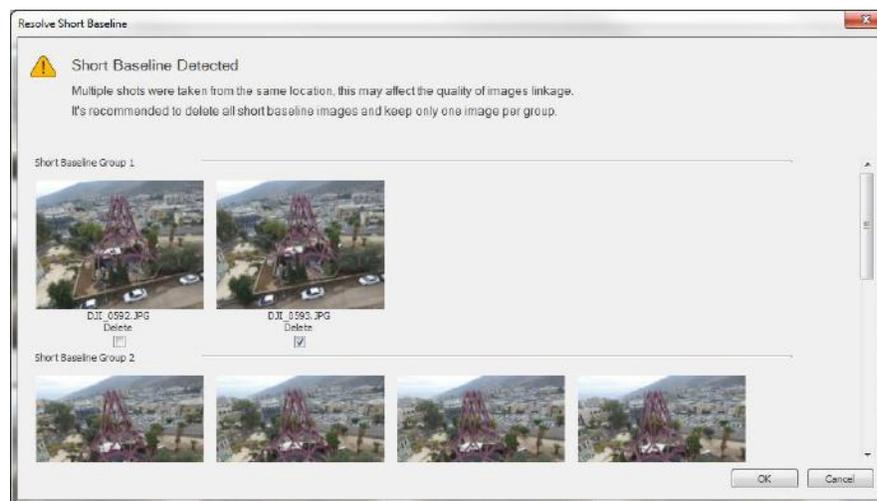


Figure 36 - Resolve short Baseline

6.3.2 Manually Linking Image Clusters

If the angles of photographing are extreme, images cannot be automatically linked into a single cluster of images and several unlinked clusters are created. Each image is marked in its bottom left corner as to what cluster it belongs to. The list of clusters is shown on the bottom right side of the screen. The list initially shows only main clusters where the number of images in these clusters is more than 20% of the images linked. You may use the “Show all clusters” link to show the rest of the clusters in the list. Only clusters with 3 images or more will be shown. This is also true in any window where a cluster list is shown.

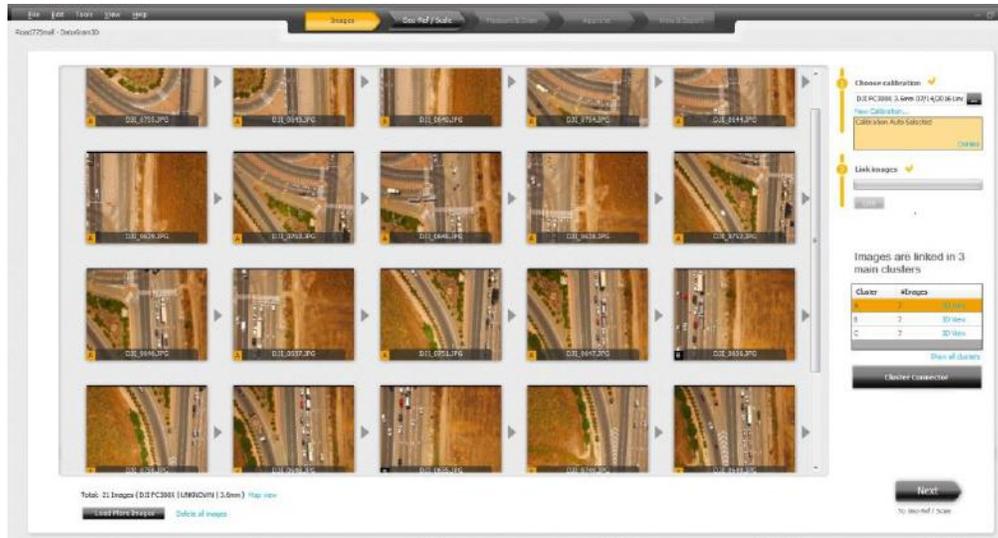


Figure 37 - Multiple image clusters

You may select to ignore the fact that you have multiple clusters and continue your work dealing with several clusters in the jobs, which will be basically handled separately throughout the job as sub-jobs. Otherwise, you have the option to attempt to connect the clusters by adding tie points.



Manually connecting image clusters is a feature available as an advanced function. If you do not have it and do want to use it, please use the menu option Tools/Settings and turn it on in the "Advanced" tab.

To connect image clusters, click the **Cluster Connector** button, which opens the window below.

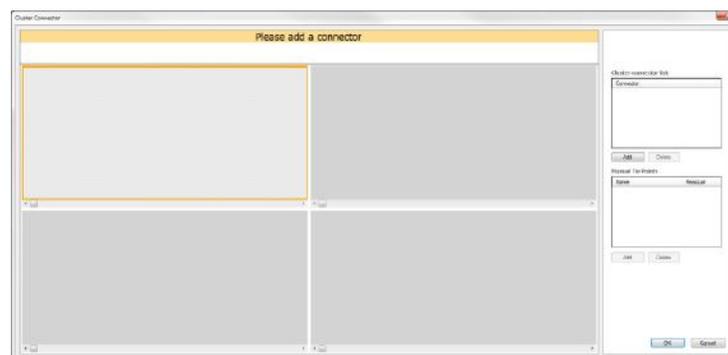


Figure 38: Cluster Connector

The manual clustering process requires adding sets of 6 or more tie points between each two clusters you think it will be possible to link. These sets of tie point are called connectors. It is possible to add one or more connectors between and two adjacent clusters, but each one of the connectors needs to have a minimum of 6 tie points

 **Note** If all images were initially linked into one cluster, no merging is necessary and, the **Cluster Connector** button is not displayed.

If a large number of clusters include one particular image, change the order of the images so they reflect their actual appearance in the field where they were taken.

To add cluster connectors:

1. Click the **“Add”** button below the connector list.



2. Select two clusters from the drop down list and click **OK**. This will automatically select the last two images of the first cluster and the first two images of the second cluster. See below.

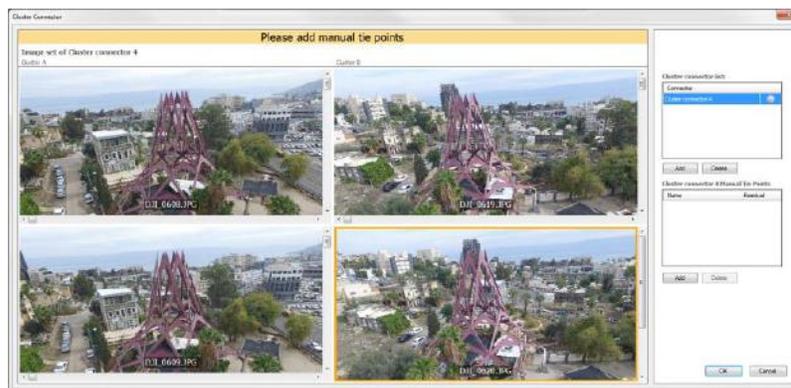


Figure 39 - Adding a cluster connector

3. Add at least 6 tie points on all shown images by clicking the **“Add”** button below the manual tie point list, and marking the tie points on all the images with a left mouse click. You may zoom images as needed to identify and mark points. Once the third tie point is marked on all images you will start seeing residual values indicating how good your markings are.

4. When sufficient tie points have been identified, click the OK button and link images again.
5. Once you are happy with the link process and cluster result, then you can move forward to Step 2 = Geo-Ref / Scale.



Upon loading the images, DatuSurvey™ automatically calculates the relative orientation of the images by finding homological tie points through state-of-the-art image processing algorithms.

6.3.3 Viewing Clusters in 3D

After a successful link is completed, the “3D View” option “” at the top left corner becomes available to show the Sparse Point Cloud in a 3D viewer. See figure below:

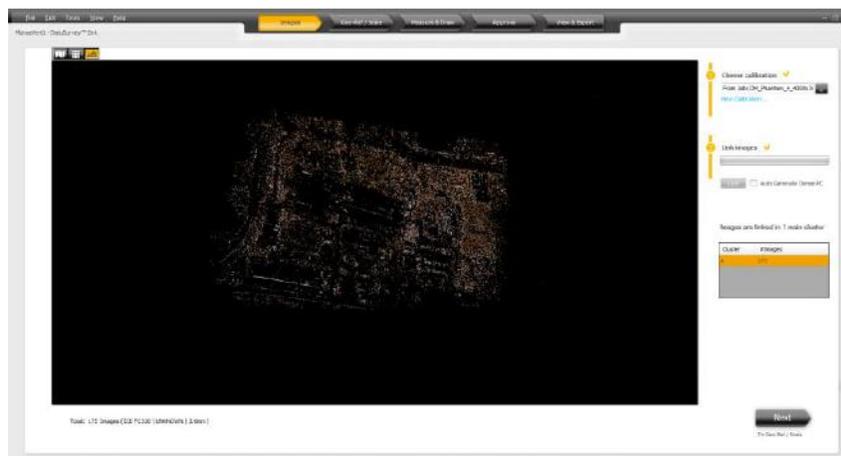


Figure 40 – Sparse Point Cloud Display.

6.4 Step 2: Geo-Ref / Scale

Starting with version 5.0, you have the option to select one of 4 working modes for each one of the clusters. See figure below:



Figure 41 - Model Referencing Modes

For Geo-Ref and Scale clusters you may define as many control points and as many scaling distances as you want. For Rough Scale clusters you will be able to define only one rough distance. For Geo-Tag mode you do not need to define anything. The system will set the project orientation and the scaling based on the image geo tags. Adding your GCP's and your scaling distances will be described later in this section.

While working with all 4 modes it is possible to add Floating Control Points (FCP's) to strengthen the coherence between images. This will improve the accuracy of all functions, especially when the project includes a lot of images. FCP's are basically control points with no coordinates. So you may define any clear feature in two or more images and it becomes a control point, and you may define as many as you want. To add an FCP under any mode, you can use the  tool bar button and click anywhere on the image to add a new FCP or mark an existing FCP. See full instructions on this in section [6.4.5](#) below.

The following pages will describe how to work with the different modes.

6.4.1 How to work in the Geo-Ref/Scale stage

The Geo-Ref/Scale tab sets the basis of how accurate the model will be. Regardless of which mode you are in, if you start correctly in this stage, then everything will be right and accurate throughout the whole project. This is particularly important when you work in the Geo-Ref or Scale mode as this will set the geo referencing or scaling. When working in Rough Scale or Geo-Tag modes, it is assumed that accuracy is not as important at this stage, but could be later if you decide to switch the job back to either Geo-Ref or Scale mode.

For each mode there are some minimal definition requirements the system needs to be able to refine the camera position and orientation parameters so they will minimize projection errors. This refinement calculation is referred to as **Bundle Adjustment**. The Bundle Adjustment calculation can be re-done at any time to improve the refinement of the parameters, and can also be based on different points including GCP's, FCP's, new points (not including topo points), and distance end points. The more points you use the better the refinement is, but it takes more time. These minimal requirements are mentioned in other places in this document, but for convenience, here they are again:

- **Geo-Ref minimal requirements** – A minimum of 3 Ground Control Points marked in 2 images covering a span of about 90 degrees. Meaning that you should mark each control point in at least two images where the angle between the first and the last image is close to 90 degrees. **It is strongly recommended though to mark 4 GCP's and mark each one in at least 3 images.**
- **Scale minimal requirements** – A minimum of 2 distances marked in 2 images with the gravity direction set. The two images should be covering a span of about 90 degrees as explained in Geo-Ref minimal requirements.
- **Rough Scale minimal requirements** – Only 1 distance marked in 2 images with the gravity direction set. The two images should be covering a span of about 90 degrees as explained in Geo-Ref minimal requirements.
- **Geo-Tag minimal requirements** – No marking is required. The system will use the image location in the EXIF data and uses that as the basis for orientation and scale.

Once the minimal definition requirements are met for the selected image cluster, the system will calculate the refined parameters. This is done by clicking the Apply button. After clicking the Apply button you will see the box below indicating the calculation is in progress.

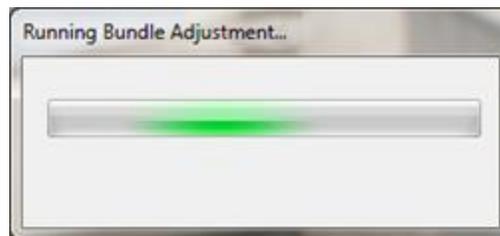
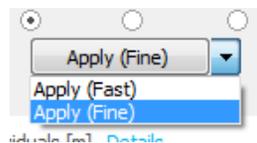


Figure 42 - Pressing the Apply Button

As shown below, the Apply button has two modes; Fast and Fine. The Fine mode uses a high number of tie points to do the refinement, hence it is more accurate. The Fast mode on the other uses a subset number of tie points, so it takes a very short time to give you some preliminary results of residuals. It is recommended to use the Fine mode the first time you satisfy the minimal criteria. Once this is done, then you can use the Fast mode when adding new points. Once you are done and before you move to the next stage, you should hit the “Apply (Fine)” one final time to build a precise model before you move on.



Every time the Apply button is pressed, the system will do a full refinement calculation (SBA). This will provide marking accuracy residuals for GCP's FCP's and distances depending on the mode in which you are working. Once this refinement is done, the user may elect to add, adjust, or delete points or distances. When this is done, the system gives a message that the model has changed and you need to press the Apply button. It immediately updates the marking residuals

for the point that was changed using a quick transformation calculation, therefore **it is not necessary to click the Apply button after every change.**

Once you have completed your Geo-Ref, Scale, or Rough Scale and point adjustments, hit the Apply button again. This will recalculate the referencing allowing you to go to the Measure & Draw routine. Finally, when you finish all your markings, and hit the Apply button. During this process, the system will re-calculate the coordinates of all the new points including topo points, and it will display the progress bar shown below. Once done, it will move to the selected tab.

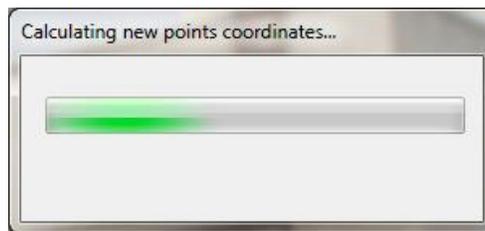


Figure 43 - Calculating New Point Coordinates

Below is a general recommendation of adding control points or distances for each cluster of a new project.

6.4.1.1 Geo-Ref Clusters

1. Satisfy the minimal requirement. – Add a minimum of 3 ground control points (*strongly recommend 4 GCP's*) on at least two different images (*strongly recommend 4 GCP's on at least 3 image each*) staying away from images on the edges. When marking ground control points, select images that are about 90 degrees between the first and last one. Make sure the ground control points appear around the outside of the area or interest. This allows the values will be interpolated and not extrapolated.
2. In large scale projects photographed vertically especially long roads, you should mark enough control points to cover all the project. For example, mark control points in the beginning, middle, and end of the road.
3. Press the Apply key. If the residuals are not good, go back and check your markings and adjust where needed, pressing the Apply button again until you have good residuals, meaning all residuals are green.
4. Turn on projections.
5. Start checking some images that are far from the original images where you marked the GCP's and see if the projections are at where they should be. If needed add more ground control points and/or floating control points to improve the projections. Please be sure that every control point is added to at least 3 images.
6. Once finished. Press the Apply button again.
7. Repeat steps 4 and 5 till you are satisfied with the projections.
8. You may now move to the Measure & Draw.

6.4.1.2 Scale Clusters

1. Satisfy the minimal requirement. – Add distances and set the gravity. When adding the first set of distances, select two images that are about 90 degree to each other. Make sure the distances appear in both of them. Try to use distances that are not very short in relation to the area of interest.
2. Press the Apply key. If residuals are not good, go back and check your markings and adjust where needed. Press the Apply button again until you have good residuals.
3. Add more distances and/or floating control points to strengthen the ties between the images. Make sure you distribute the new distances and floating control points throughout the entire cluster.
4. Press the Apply button again and check residuals.
5. Repeat steps 3 and 4 as you deem necessary.
6. You may now move to the Measure & Draw.

6.4.1.3 Projections of GCP's, FCP's and Distances

It is possible to show the projections of Control Points as well as Distance end points on other images. Projections are shown after a model is built, meaning after the “Apply” key is pressed the first time, on images in the same cluster.

To turn projections on simply check the Projections check box on the upper right corner of the Geo-Ref/Scale screen shown below:



To select what will be projected press on the Projections... link shown in the figure above and this will open the window shown in Figure 44 below that will allow you to make your selection. The Projection Settings here are global and not for a specific cluster. Meaning they can be set and saved for a job regardless if there are Control Points or Distances in the job. Projections of Floating Control Points and Distances projections will be made in the cluster they are marked in, while Ground Control Points projections may be marked in images in any Geo-Ref'd cluster if possible.

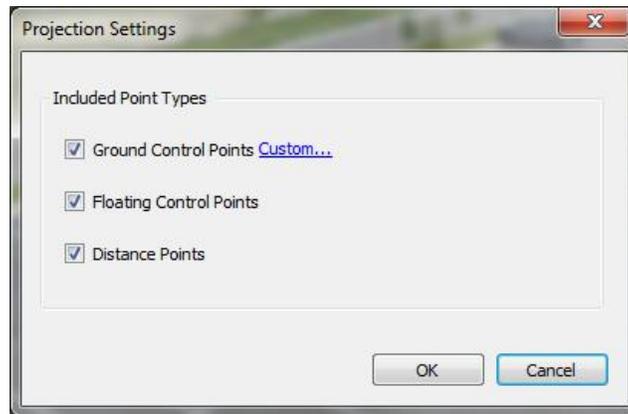


Figure 44 - Projection Settings

The Custom... link allows you to select a subset of Ground Control Points to be projected. Selection window is shown below.

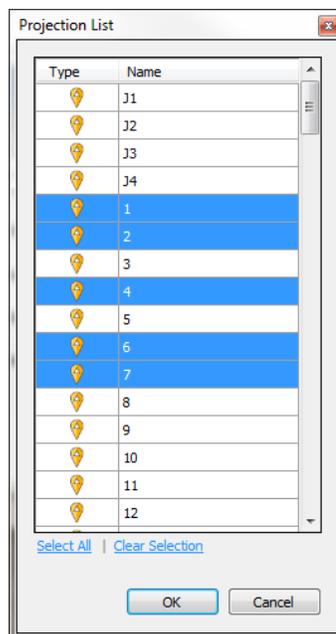


Figure 45 - Projection List Window

General guidelines:

- GCP's are projected only in Geo-Ref'd clusters. Selection made here also applies to the Measure & Draw window but may be changed there also.
- FCP's are projected in all cluster types only in the Geo-Ref/Scale stage.
- Distance Points are projected only in Scale and Rough Scale clusters only in the Geo-Ref/Scale stage.

6.4.1.4 Show Names

Check or uncheck the “Names” checkbox to show or hide the point and projection names on the images.

6.4.2 Working in Geo-Tag mode

Working in Geo-Tag mode means that the model that will be built will be:

1. Anchored – The anchoring will be based on the image geo-tagging information available in the EXIF data of the images. You are not required to set gravity or scale.
2. Roughly scaled – Meaning that it will have rough dimensions – The model will be built based on geo-tagging information.

6.4.3 Working in Rough Scale mode

Working in Rough Scale mode means that the model that will be built will be:

1. Floating - Meaning that it is not anchored to the ground and does not have a perfect orientation. You are required to set the gravity direction, so the model will be correct vertically, but it will not have the correct azimuth (Angle from North).
2. Roughly scaled – Meaning that it will have rough dimensions – The model will be built based on the specified rough scale but it will have the right aspect ratios.

Working in this mode is suitable for the following purposes:

1. One wants to build a model for a presentation to show the model or advancement in building processes or excavations or filling processes without the need to have control point measurements.
2. One has images from a certain job, but does not yet have ground control points or distances measured. In this case it is possible to start all the drawing processes and when the survey area is measured, then ground control points or distances can be added, and the work can be completed.

To work in rough scale mode, simply select the rough scale option for a specific cluster, follow the instructions to define one rough distance and define the gravity similar to what is described in “Working in Scale Mode” below, click Apply, and go to Measure & Draw. Rough scales name will start with the letter “R” indicating the measurement was roughly estimated.

6.4.4 Working in Scale mode

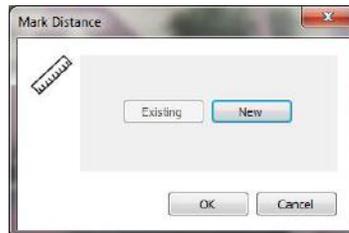
Working in Scale mode will allow adding a measurement reference to the job. This will allow taking accurate measurements between new points, as well as building right size models. The benefit is that this can be done without any special surveying tools. Stock pile volume calculations is ideal for Scale jobs, since volume calculations do not require geodetic positions or orientation.

Scale is easy and can be done by measuring as few as 2 distances in the field, then marking these measurements on at least 2 images. When distances are added, the Distance Marking Accuracy measured will provide residuals for both the distances and for end points. This will be shown in the right pane of the application similar to the Control Point Making Accuracy table.

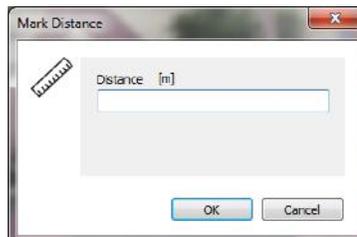
To add a distance while working in Scale mode follow the steps below:



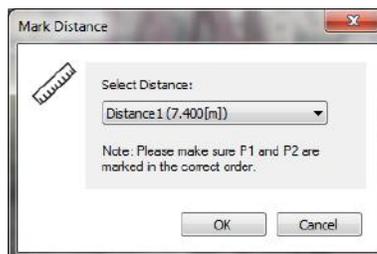
1. Select the distance marking tool from the tool bar and a distance marker with the number 1 is attached to the mouse pointer.
2. Mouse over to the first end of the distance you wish to mark, and click it. You may zoom in as needed to mark the right point. It then will prompt you to determine if this is a new or existing distance you are adding.



3. If this is a distance you have previously marked on other images, select Existing.
4. If this is a new distance, enter the measured distance in the field below.



5. If you picked an existing distance, select one of the available distances from the drop down options.



6. Click OK, and a distance marker with the number 2 is attached to the mouse pointer
7. Mouse over to the second end of the distance you wish to mark, and click on it. You may also zoom in here as needed to mark the right point.

- Repeat the step above to add more distances as needed. All distances will appear in the Distances list as shown below in Figure 46.

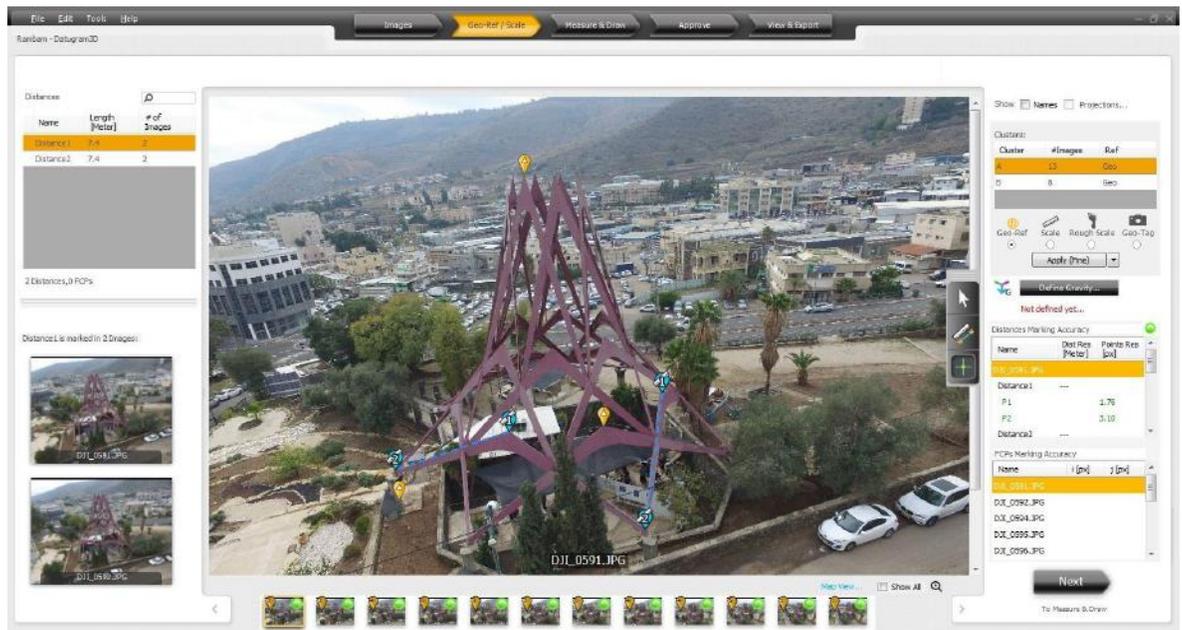


Figure 46 - Scaling Distances

- Define the model gravity, by clicking on the “Define Gravity” button. If images have GPS data the system will try to automatically define gravity vector based on GPS data. If it succeeds to do so, it will display a message below the Define Gravity button saying that Gravity was defined automatically, otherwise, the dialog below will be opened to allow the user to manually define the gravity vector.

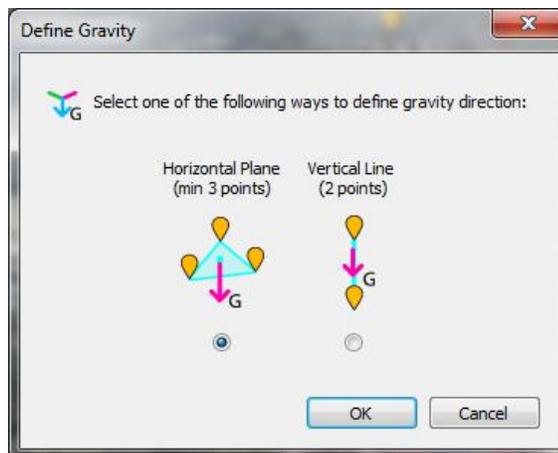


Figure 47 - Define Gravity Dialog

As you see, there are two ways to define gravity direction. One is by a vertical line you see in one of the images, but if no vertical line exists, it will be possible to define a horizontal plane. Both definitions use existing points including GCP's, FCP's, or distance end points. If you do not already have suitable points, you will need to add FCP's for this purpose. Otherwise make your selection and press OK. The mouse



cursor turns to this icon

Select points as instructed. Each point you select will be marked clearly with an icon



like this. Additionally all points that are participating in the gravity setting will be clearly marked with the letter G in the list of points or distances on the top left part of the Geo-Ref screen. Pay attention, the software will do its best to detect the direction of the gravity based on the images, but you will always have the option to flip the software's detection with a click of a mouse on the "Flip Gravity" button in the 3D Model screen under the View & Export tab.

10. Once you satisfy all of the requirements of distances and gravity, press the Apply button and then move on to Measure & Draw to continue your work.

6.4.5 Working in Geo-Ref mode

Control points are the measurement points taken in the field using traditional geodetic measurement equipment, such as a robotic total station or RTK GPS. With DatuSurvey™, there is no need to collect dozens of measured points in the field as is done conventionally. You only have to measure a few, well identified points that are uniformly spread over the job's area. Each control point should be a measurement of an object existing on at least two images. The number of required control points is a factor of the complexity of the site but new control points can easily be added as you move forward so there is no need to overpopulate an image.

6.4.6 Importing Control Points

The control point measurement file, containing the project's control points, should be imported at this stage.

1. Click **Import** and select the measurement file. The "Import Measurement" window is populated by the control-points data measured in the field. It is recommended to have a text file (.txt, .pnt, or .csv) of your field measured control points.

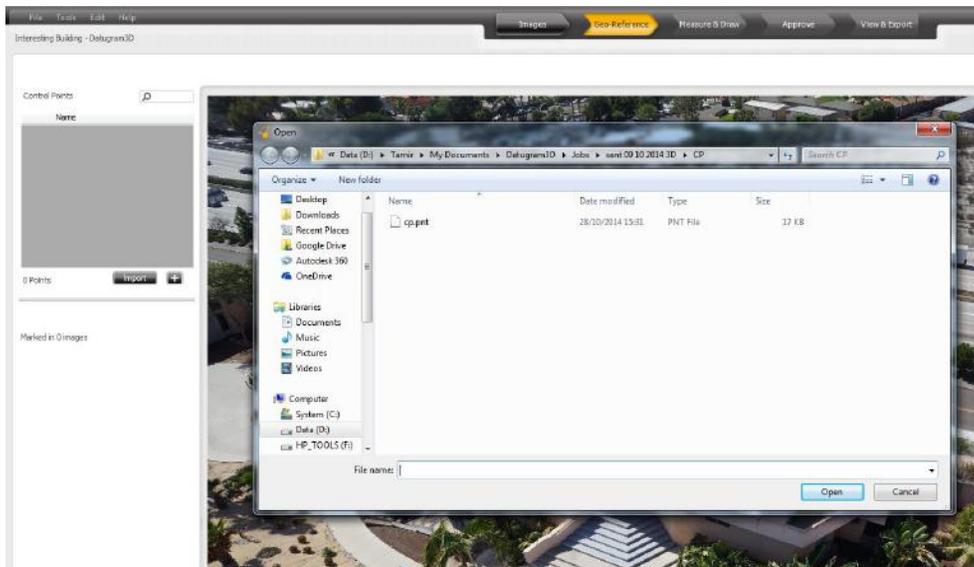


Figure 48: Selecting the Control Points File

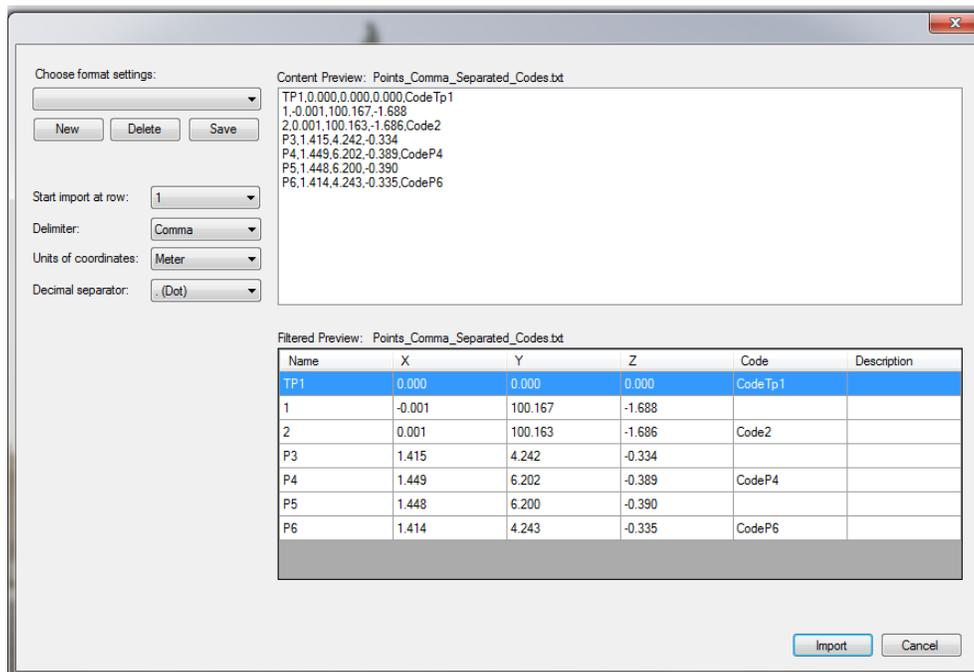


Figure 49: Import Measurements Window – View of TP (Control Points) File, Prior to Import

- The “Import Measurement” window (Figure 49) shows how DatuSurvey™ parses the control-points file. If the parsing is not correct, you can set the correct delimiter, change (by dragging) the order of the coordinate columns, and set the decimal separator. The default measurement unit is meters but you can change it by selecting other units from the dropdown list.

- a. The “<file_name> content preview” field shows the original text as they exist in the file.
 - b. The “<file_name> filtered preview” field shows the interpretation of the file in which the contents have been parsed to Name, N, E, H (coordinate values), Code name, Description, and Point Comment.
3. To save the formatted parameters, click **New** and provide a Format name for the New Format.

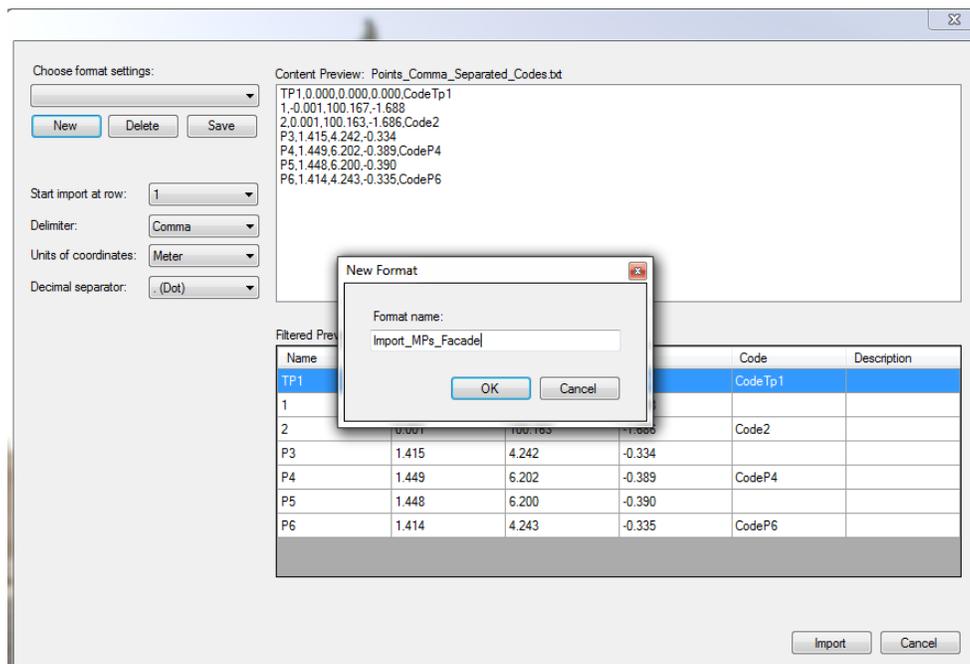


Figure 50: Saving Import Measured Points, Format Interpretation

4. To delete a format setting item from the “Format Settings” list, select the item from the dropdown list and click **Delete**.
5. To save a format settings item in the “Format Settings” list, click **Save**.
6. If point attributes within the TP file are ordered differently from the default order, columns can be dragged and reordered.
7. Use the **Start Import at Row**, **Delimiter**, **Units of Coordinates** and **Decimal Separator**, to modify the formatted imported parameters.
8. Click **Import**. DatuSurvey™ checks the control points to verify that a point with the same name does not already exist in the job. If it does, the application prompts the user with a dialog box to skip, rename or overwrite the existing point.



During the import process, a control point with a code that already exists in the job's codes library receives that particular code. Other control points remain without codes.

6.4.7 Marking Control Points

Images are anchored by control points. Reference points, before being anchored, are called projections. Projections as well as marking residuals are shown after meeting the minimum marking requirements. The screen below shows the basic Geo-Ref/Scale window followed by an explanation of its components.

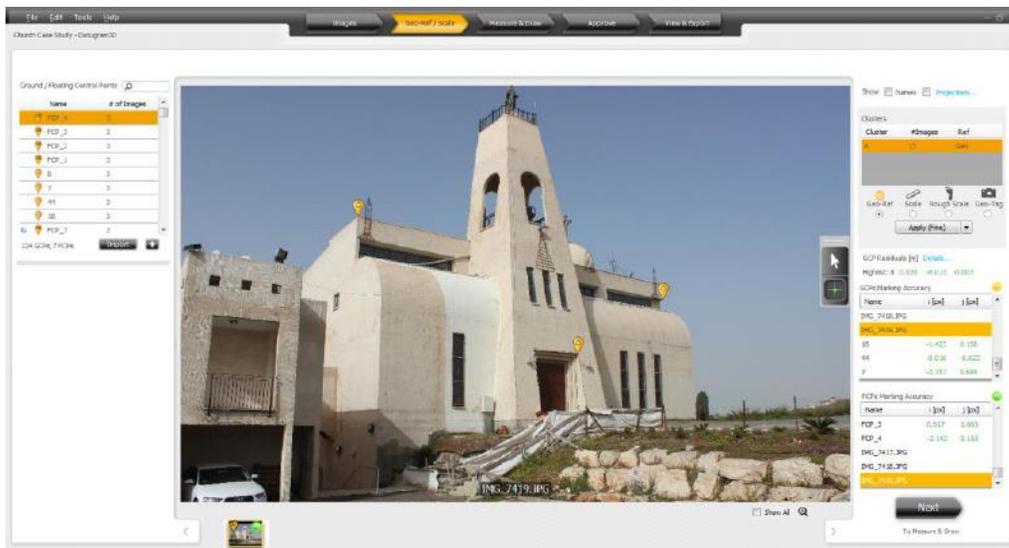


Figure 51: "Geo-Ref/Scale" Window

Left pane:

Control Points – This is a list of all imported or manually added Ground Control Points and Floating Control Points. If the Control Point is marked on at least one image, an anchor icon

is shown to the left of the control point name. The icons are different for GCP's  and

FCP's  both on images as well as on the table on the top left. In the screen shot above 4 control points are marked on at least one image.

Images below control points list – Here all the images that the selected control point appears in are shown with the control points marked.

Right pane:

Show Names and Projection – These check boxes enable and disable showing the names of the control points and the projections as well as showing the projections themselves. It is possible to select the points that you would like to see projections for by pressing the Projections... link on the same line. Projections are shown after meeting the minimum marking requirements.

Clusters – a list of image clusters built by the link process with the option to select the referencing mode for each cluster. Selecting a cluster from the list shows the thumbnail images of the selected cluster as well as showing one of the cluster images on the center display.

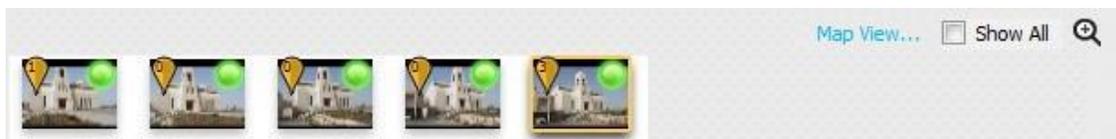
GCP Residuals [m] – in this section the system shows the point with the highest residual in the actual measurement unit, meaning meters, feet... The “Details...” link can be used to show all marked points residuals without having to go to the View & Export screen.

Control Points Marking Accuracy – Residuals of all markings are shown here. Values are automatically shown after meeting the minimum marking requirements, and are updated every time a point is added, deleted, or moved. Colors of residuals indicate their quality. Ranges for each color may be set in the Tools/Settings option in the Accuracy Display tab.

Bottom Thumbnail Banner:

Thumbnails of all selected cluster images is shown here and it allows selecting the image you want to work with by clicking or dragging it to the main image display.

On each thumbnail you may see two indicators as shown below. In the upper left corner you will see the number of control points marked in this image, and in the upper right corner you will see the color of the overall tie point detection accuracy on this image.



On the upper right corner of the banner you will have the option to check the option to:

1. See a Map View if images are geo-referenced. The map view will also allow you to select the image that will be displayed in in the Geo-Ref/Scale tab for processing and adding control points
2. Show images of all clusters.
3. Open an expanded view of images by pressing the  icon.

Main Image Display:

Main display is where all work is done as far as marking and editing the control points. The screen shown below displays an image with all of the different options including projections.

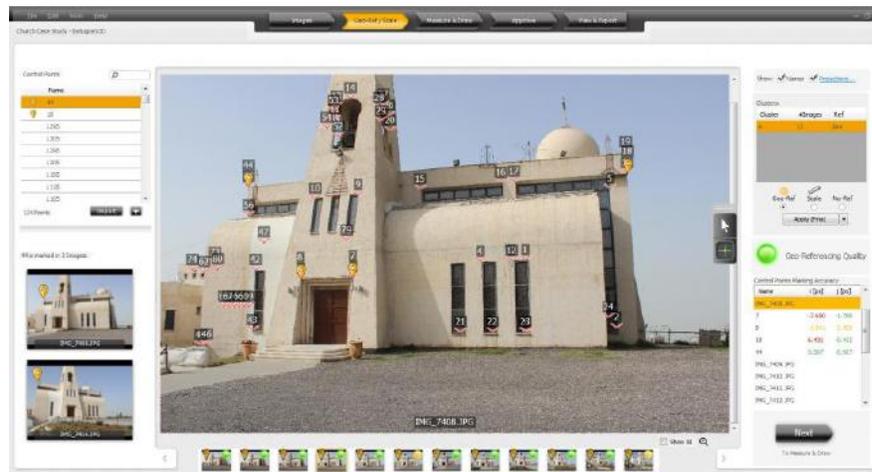


Figure 52 - Marked Image



To view information about one or more control points, click the Indicator icon () and, mouse over the desired control point. The control point will be highlighted and if **Names** was not previously checked, the name of the highlighted point will be displayed.

Right-click a control point to display a context menu. This permits performing several actions on the point, including displaying the Properties of the point. The same context-menu appears if you right-click on a control point on the “Control-Points” list in the window’s left pane.

6.4.8 Anchoring Control Points

To anchor a previously defined ground or floating control point on images:

1. Select a cluster (group of linked images).
2. Then select an image from the selected cluster by clicking on images or dragging to the viewer from the thumbnail banner images or from images in the left pane.
3. Click the Point Selection icon (). A crossbar cursor appears over the image.



To zoom in on a particular area of an image, use the scroll wheel on the mouse to adjust the size of the image.



To scroll through an image, right click and hold the mouse right button and drag the image in any direction.

4. Zoom into the area of where you want to mark the control point, put the cursor on the right position and left click to mark it. The “Mark Control point” dropdown box is displayed.



Note that the projection marker is to assist in finding the vicinity of the point. You should put your mark on where the point was originally measured in the image and not on the projection marker itself.

5. Click on the arrow in the “Name” dropdown box (Figure 53) and select the relevant control point based on its name and the field sketch (or image) detailing the control points measured in the field.
6. Click **OK**.

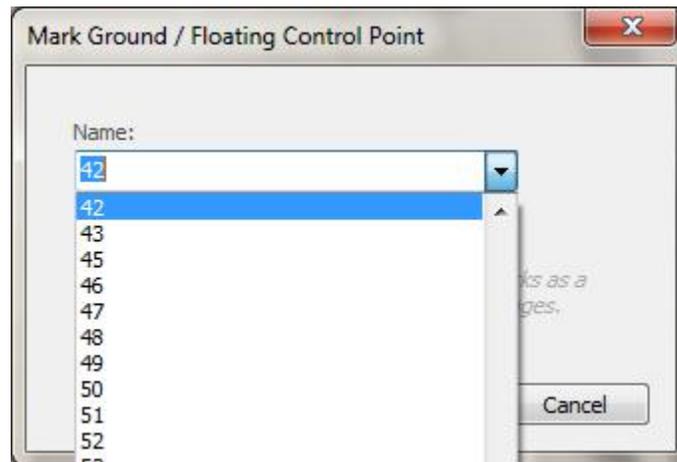


Figure 53: Marking Control Points

7. Repeat this process until you have marked at least three Ground Control Points and as many Floating Control Points on at least two images. It is recommended that you distribute the points to identify the width, length, and height of the project.



Revising the position or coordinates of a control point will change the geo-referencing of the photogrammetric model, and will change the coordinates of any new point measured on the images.

8. Ground Control Point properties can be edited during this process. Click the Indicator icon then, right click on the control point, on the image, or in the list of control points to provide a list of operational functions related to each control point.

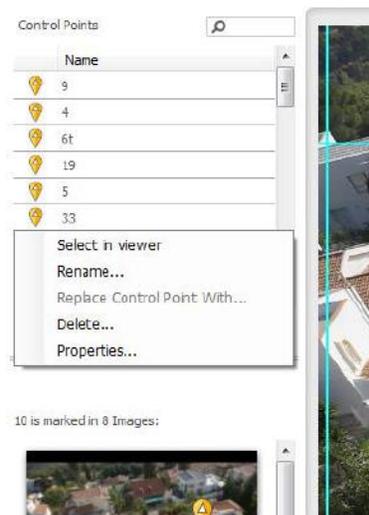


Figure 54: Control-Point Context Menu

- Click **Select in Viewer** to highlight the selected point and display its name.
- Click **Rename** to rename a point without changing its coordinates.
- Click **Replace with** to replace the point's name and coordinates with one of the points in the TP measurement file.
- Click **Delete** to remove a point from the list. Several options are provided:
 - Delete point from entire job.
 - Delete mark from this image only.
 - Delete mark from all images.
- Click **Properties** to manually edit the point coordinates (Figure 49).

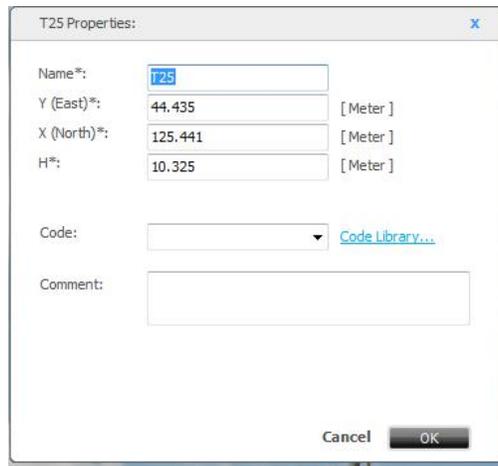


Figure 55: Editing Control-Point Dialog Box

9. Subsequent to the creation of each new control point after meeting the minimum requirement will recalculate and display the residuals. Hence, if residuals get bad after adding a point, then you should go back and recheck the position of that point in all images it which it is marked.
10. Click on any of the points shown in the “Control-Points” list (left pane) to display all images that contain that particular point. Thumbnails of the images are shown below the “Control-Points” list.
11. Click on a thumbnail in the “Control-Points” list (left pane) to display that image in the main window.



To locate a particular control point, use the “Search” window located at the top of the “Control-Points” list.

6.4.9 Adding a New Ground Control Point



If a control point is deleted, all its projections will be removed. Similarly, If a control point is restored (using the undo function), all its projections will be restored.

If an important projection is missing in the TP measurement file, a new control point can be created. The relevant information with the required parameters should be provided by a surveyor who worked in the field.

1. To manually add a new control point click the “+” button below the “Control-Points” list.

2. In the “New Control Point” window, fill in the coordinates and other related information. Provide a code (if available) and description and click **OK**. The Code is only relevant when provided for a measured point by the TPS.

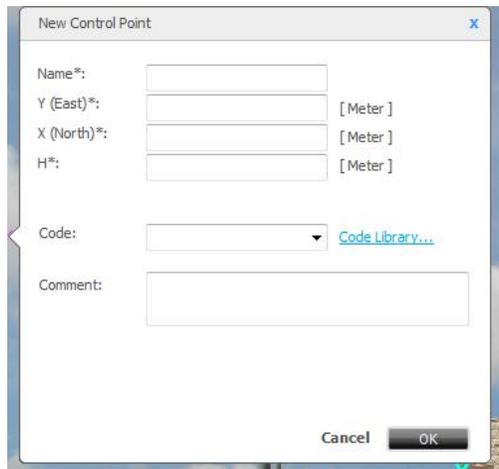
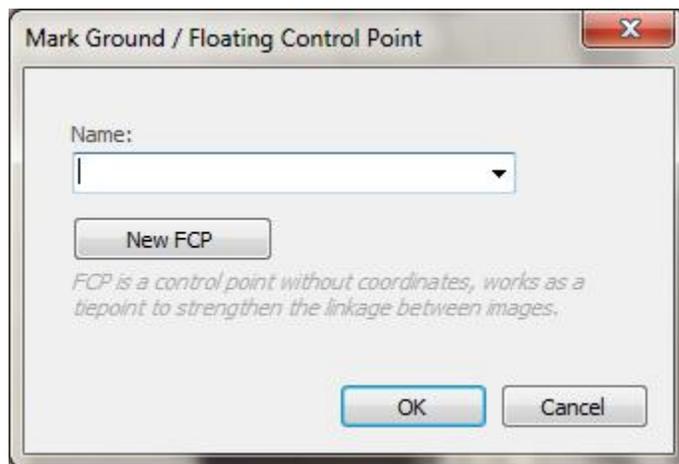


Figure 56: “New Control-Point” Dialog Box

6.4.10 Adding a New Floating Control Point

1. To add a new floating control point, Click the Point Selection icon (). A crossbar cursor appears over the image.
2. Click on the location on the image where you want to add the new floating control point. This will show the dialog below:



3. Press on the New FCP button, and the will add a floating control point names FCP_x, where x is a running number assigned by the system. Once you add a new point on one image you can anchor it on other images following the same method as adding a pre-defined ground control point.

6.4.11 The Geo-Referencing/Scaling Marking Accuracy Indicator

Marking accuracy calculation should be performed in the following instances:

- After marking at least three control points on two images in the survey area.
- Whenever any of the existing control points (GCP or FCP) is edited.

DatuSurvey™ calculates the geo-referencing of the photogrammetric model based on ground control points, floating control points, and distances in the images. It compares the relative orientation of the images inferred from the geo-referencing to the relative orientation implied from the automatic image processing of tie points. Additionally the user may also include or exclude all points mentioned above as well as new points drawn on the images in the calculation by setting the SBA (Sparse Bundle Adjustment) options in the SBA tab of the settings window.

The color of the Marking Accuracy Indicator (green, yellow or red) indicates the accuracy of the photogrammetric model. A green light indicates the accuracy is good. A yellow light indicates that accuracy of the photogrammetric model is fair, and a red light indicates that accuracy of the photogrammetric model is poor.

1. To recalculate the photogrammetric model, click **Apply** button at any time.
2. Check and edit the exact anchoring of any control point that has large residuals, as indicated by yellow or red marking, by comparing it to the field sketch.
3. Repeat this procedure until the Marking Accuracy Indicator is green, or when you are satisfied the marking accuracy meets your minimum requirements.

6.4.12 Marking Accuracy List

Marking accuracy determines the difference between the marked position and the calculated or predicted position of any point. All residuals are important because it shows how accurate the marking is. The residual is determined by taking the predicted value and comparing it to the marked value.

Image marking accuracy residuals are always measured in pixels so that their absolute value in centimeters or inches is relative to camera resolution and the distance between the camera and the object.

DatuSurvey™ is pre-configured so that measurement errors smaller than 3 pixels are colored in green, measurement errors of 3 to 4 pixels are colored in yellow, and measurement errors larger than 4 pixels are colored in red. These parameters are configurable by the user in the Settings window (refer to Section 7.2.1).

- 1 Check and edit the exact anchoring of any control point that has large residuals, as indicated by yellow or red markings, by comparing it to the field sketch, and recalculate the geo-referencing of the photogrammetric model.
- 2 Click on any point in the residual list in order to view thumbnails, under the “Control-Points” list (left pane) of all images containing that particular point.

6.4.13 Export Camera Calibration

In the event that the job results are suitable you can use this particular job for future internal camera calibration. Suitable results are indicated by the existence of a single cluster with the Geo-Referencing Quality Indicator being acceptable (green).

1. In the Tools menu, select “**Export Camera Parameters**”.
2. In the Tools menu, select “**Calibration Library...**” option and Import this new Calibration file by clicking on the **Import** button and selecting the file recently saved.

6.5 Step 3: Measure & Draw – Marking and Creating New Points

The survey drawing is created on this window. To perform this function, you can add map entities such as New Points, Polylines, Polygons or Surfaces. Furthermore, linear distances between two points can also be measured. Remember that when you have more than one cluster, each is handled separately. So New Points or object marked on one image will be projected on images from the same cluster only.

To establish the coordinates of a new point, the point must be identified on at least two images, and preferably more. Any new point marked in one image is automatically found in all others.

A number of tools are available on the “Measure & Draw” window to facilitate the process of creating a survey drawing.



Figure 57: “Measure & Draw” Window

6.5.1 Layers and Objects

6.5.1.1 Working with Layers

A layer is used to group several map entities into one set. Usually entities of one layer have some common attributes that distinguish them from points in other layers. For example, they may define a window frame layer or a road sign layer. Layer are define cross job, so they can be used in any cluster.

The various layers in DatuSurvey™ can be checked or unchecked in the “Layers” list, in the Show column. This substantially reduces the possibility of confusion if you wish to visually concentrate on a specific group of entities.

By default, when DatuSurvey™ opens a new job, it contains one layer called the “default layer”.

User can right-click on a layer and call up its context menu which has the following options:

- Delete Layer – deletes the layer and all its contents.
- Properties – shows the “Layer Properties window, containing layer name, description and color and enables editing those properties (Figure 58).

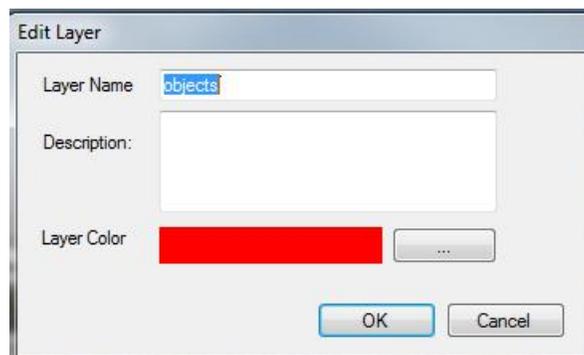


Figure 58: Layer Properties Window

To create a new layer:

1. Click on the + below the “Layers” list in the right pane, to open the “Add Layer” dialog box (Figure 59).

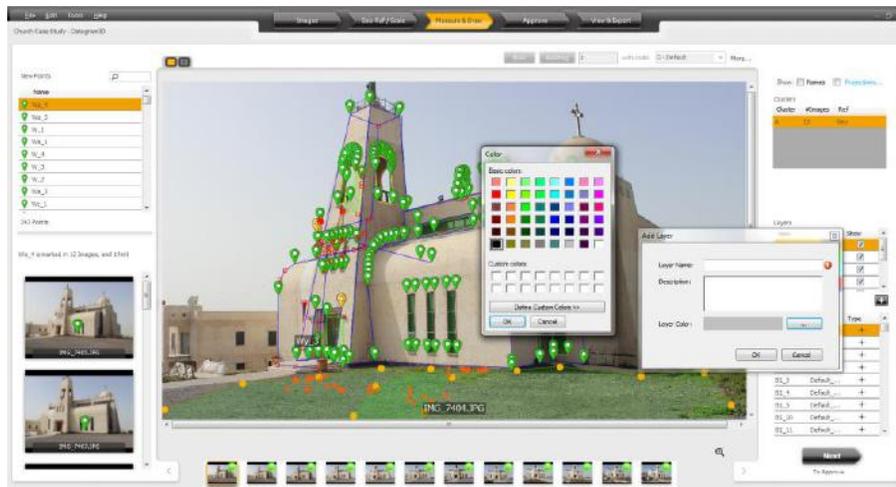


Figure 59: “Add Layer” Dialog Box with “Color” Selection Dropdown Box

2. In the “Add Layer” dialog box, add a name for the new layer and a description and click on the **Layer Color** button to open the “Color” selection dropdown box.
3. Select a color for the layer. The color assists the user in quickly identifying entities in a particular layer.
4. Click **OK**.

6.5.1.2 Working with Objects

Each layer contains its map entities (objects) which are displayed in the “Objects” list below the “Layers” list. When you draw map entities, they are automatically associated with the selected layer in the “Layers” list.

1. Select an object, and a certain entity or list of entities will be highlighted on the image.
2. Right click on an entity to show the context menu that enables the deletion of the entity.



In the case of polylines and polygons, only the lines are deleted but not the new-point objects.

6.5.2 The “Measure & Draw” Toolbar

The “Measure & Draw” toolbar contains the tools presented in Figure 60:



Figure 60: The “Measure & Draw” Toolbar

The **Selection and Indication** tool is used to:

- Drag and drop a point to move it, or select the point using left mouse click and move it using the keyboard arrows in 1 pixel resolution.
- Move the mouse cursor over a new point to highlight a new point. When the new point is part of a polyline or a polygon, it highlights the connected lines and new points.
- Select (left-click) a new-point entity to be synchronized with the “New-Points” list.
- Activate (right-click) the context menu of a new point.

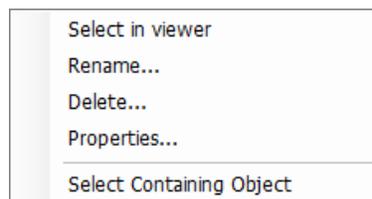


Figure 61: New-Point Context Menu

The **New-Point Marking** tool is used to create a new point.

The **Polyline Marking** tool is used to create a sequence of new-point entities. Each adjacent pair is connected by a straight line.

The **Polygon Marking** tool is used to create a sequence of new-point entities. Each adjacent pair is connected by a straight line. The first new point and the last new point are connected forming a closed polygon.

The **Topo-surface Sketching** tool is used to designate a polygon topo-surface border. After drawing the topo-surface border, DatuSurvey™ calculates a set of topographic points (topo-points) in the form of a points-cloud. This cloud represents the topography of the topo-surface enclosed by the topo-surface border.

The **Ruler Selection** tool is used to measure the linear distance between two points.

6.5.3 The New-Points List

The “New-Points” list contains all the new-point objects in the job, whether they are standalone points or part of polyline or polygon.

The “New-Points” list has an attached search box. Searching can be done by name. Typing a new-point’s name will show the appropriate named points in the list.

1. Select a point from the “New Point” list. Large image thumbnails are displayed below the list. These thumbnails refer to the images in which the selected New Point is marked.
2. Right-click on a New Point to display the New-Points list context menu. Various functions are provided to manage new points, as shown in Figure 62.

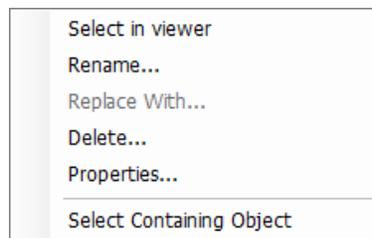


Figure 62: New-Point List Context Menu

6.5.4 The New-Point Properties Bar

The “New-Point Properties” bar is used to name new points and determine other related properties.

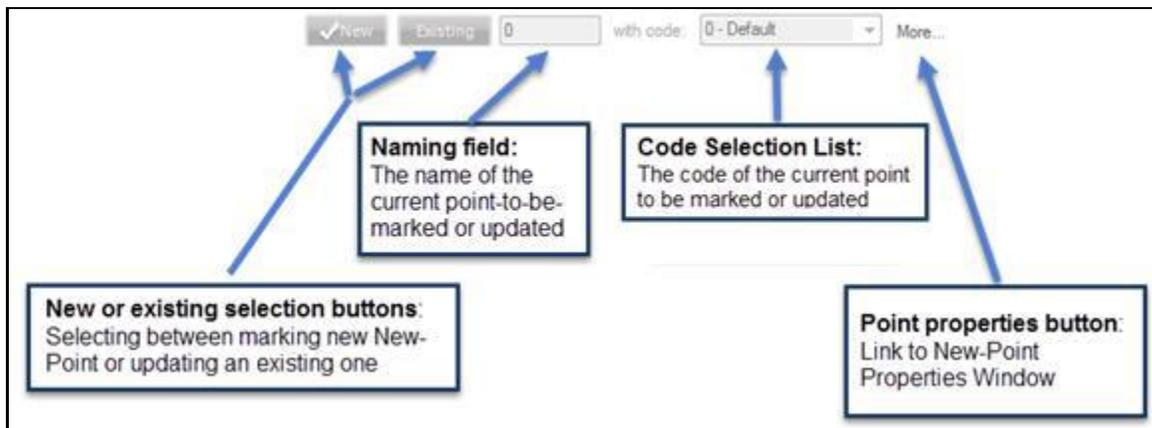


Figure 63: “New-Point Properties” Bar

6.5.4.1 Using the “New-Point Properties” Bar to Mark a New New-Point

To mark a new point, perform the following steps:

1. In the “New-Points Properties” Bar click **New**.

2. Access the “Naming” field. This field contains the name of the to-be-marked new point. The name is automatically created and is always one digit greater than the previous name. The following table provides examples of new-point names:

Previous Marked New-Point Name	Current to-be-Marked New Point Name
1	2
100	101
ABC	ABC1
ABC0	ABC1
ABC01	ABC02
72A	72A1

3. Alternately, in the “Naming” field, type a desired name manually. This will be the name base for the following new markings until you type another name.
4. Use the “Code Selection” List box to select a point code, from the existing list.

6.5.4.2 Using the “New-Point Properties” Bar to Update an Existing New Point

To select an existing new point:

1. Click **Existing** on the “New-Points Properties” bar. In the “Naming” field the name of the currently selected point is highlighted in the “New-Points” list. If another existing new-point update is needed, select another point from the dropdown list. It will be synchronized with the “New-Points” list.
2. In the “Code Selection” List box, the code of the currently selected new point is displayed. You select another code for the existing point.



In order to have selectable point codes in the “New-Points Properties” bar, you must load codes to the job’s codes library. Please refer to Section 7.2.2.1.

6.5.5 Viewing Images

Marking entities on an image requires a high degree of accuracy. DatuSurvey™ provides three images viewing modes to facilitate precise positioning of your mouse:

1. For a single image view, in the image marking area, select one image – either from the thumbnails ruler at the bottom of the screen or from the “New-Points Image” list on the left. The selected image is displayed and occupies the whole image marking area.

- For a split screen view, click on the split screen image in the “Screen Mode” bar. Drag and drop images from the thumbnails ruler into the screen quarters.



Split screen mode is useful to assure a specific marking can be projected on several images or if you want to view existing new point projections or markings.

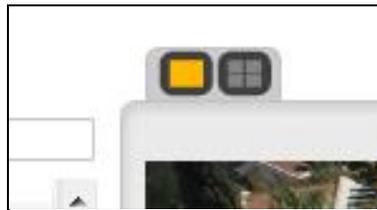


Figure 64: “Images Screen Mode” Bar

- To display an image in a separate window, right-click on the image in the “New-Point” list. A context menu pops up showing “Preview” option. Select the option, and the image is opened in a new system menu.

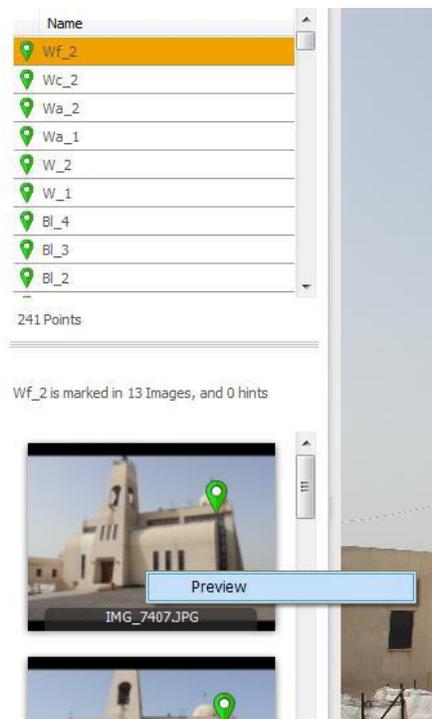


Figure 65: Selecting Displaying Image in a Separate Window



The “Preview” mode is useful if you are using two monitors. You can then drag the new window to another monitor and visually scan small features in the image. The image occupies the whole screen and can be zoomed and panned and a filtering radio button allows you to show all new points on the image or just the selected one.

6.5.6 Marking New Map Entities

6.5.6.1 Creating a New Point

To create a new point:

1. Select the layer (or create a new one) with which you want the new point to be associated.
2. Select the mapped item you want to mark.
3. Select the image/images that best display that item.
4. From the “Measure & Draw” toolbar, select the “New-Point” marking tool.
5. On the “New-Point Properties” bar, verify that the automatically-provided name is suitable. Modify the name if required.
6. Verify that the automatically-provided code for the new point is suitable. Modify the code if required.
7. To add a comment to the new point you are about to mark, click on the **Point Properties** button and type the comment.
8. Position the crossbar cursor on the desired location on the image and click it. A gray-colored drop-shaped icon is displayed. On the right pane an indication is provided that object marks are being searched on other images. After several seconds, the search process completes and the color of the drop-shaped icon changes to green, yellow or stays gray. The different colors indicate the following:



Figure 66: Example of Auto-Find Indication

- Green: indicates the point was found in at least two other images (apart from the currently marked one).
- Yellow – indicates the point was found in only one other image (apart from the currently marked one).
- Gray – indicates the image was not found in any other image.

On a Yellow or Gray icon color marking, we should select another image and mark the current point manually as "Existing" point. After this action a new Auto-Finding process will start while the two manual marks will not be changed



Use Ctrl+click to initiate a snap function to help you draw accurately. The cursor snaps onto each location, linking the points.

6.5.6.2 Creating a New Polyline

To create a new polyline:

1. Repeat steps 1 to 3 from Section 6.5.6.1 (Creating a New Point).
2. From the "Measure & Draw" toolbar, select the "Polyline Marking" tool.
3. Repeat steps 5 to 7 from Section 6.5.6.1 (Creating a New Point).
4. The first point of the polyline is created. Move the mouse to the location of the next point. A trailing line indicates that the new point will be marked as part of a polyline.
5. Repeat step 3 as many times as required, until you reach the penultimate point.
6. To mark the final point of the polyline, double-click the mouse. A new polyline is created having the color of the layer with which it is associated.



During the process of marking new points for a polyline or a polygon, it is not necessary to wait until the search process has been completed for each point. Mark as many points as necessary and the process of searching points in other images continues in the background for all points.

6.5.6.3 Creating a New Polygon

1. Repeat steps 1 to 3 from Section 6.5.6.2 (Creating a New Polyline).
2. From the "Measure & Draw" toolbar, select the "Polygon Marking" tool.
3. Repeat steps 5 to 7 from Section 6.5.6.2 (Creating a New Polyline).
4. The first point of the polygon is created. Move the mouse to the location of the next point. A trailing line indicates that the next new point will to be marked as part of a polygon.
5. Repeat step 3 as many times as required, until you reach the penultimate point.
6. To mark the final point of the polygon and close it with line connecting to the first polygon's point, double-click the mouse. A new polygon is created having the color of the layer with which it is associated.



While marking new polyline or polygon points, you can change each polyline's or polygon's new-point properties by setting them in the "New-Point Properties" bar.

6.5.6.4 Creating a New Topo-surface Entity

1. For each area you want to cover, such as a stock pile, create a layer specifically for it, and add all topo surface for the area of interest under the newly defined layer



We recommend creating special layers that include only topo-surface objects. This ensures that only the desired topo-surface features are included in the mesh.

2. Repeat steps 1 to 3 from Section 6.5.6.2 (Creating a New Polyline).
3. From the "Measure & Draw" toolbar, select the "Topo-surface sketching tool."
4. If this is the first topo-surface in the job, DatuSurvey™ presents a message notifying you that pre-processing is required. This takes several seconds.



When creating a new topo-surface, you cannot change the name of the topo-surface. It is provided automatically.

5. Circumscribe the topo-surface you want to reconstruct (calculate its topography), with a boundary polygon (use the same techniques as described in marking a new polygon, Section 6.5.6.3). You must define several topo surfaces to nicely cover the area of interest or the stock pile. Topo surfaces can be drawn on different images, but must be under the same layer.
6. When each topo-surface boundary is closed, DatuSurvey™ displays a process notification in the right pane stating that it is calculating topo-points for the drawn topo-surface. This process takes several seconds and when it completes, the topo-surface should contain several topo-points within its boundary.

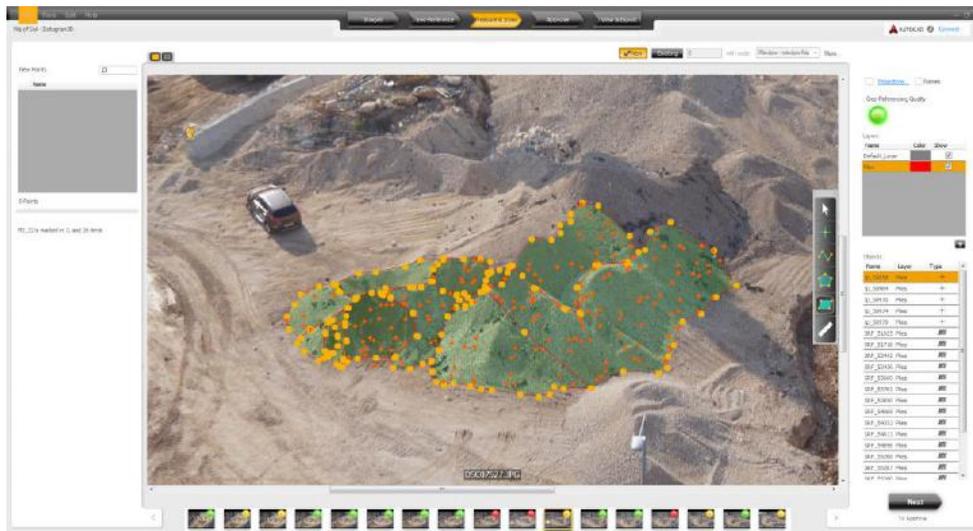


Figure 67: Topo-surface Reconstruction – Soil Pile Example



A topo-surface's boundary polygon is not composed of new-point entities. It is made of per-image points, so do not expect to find the topo-surface boundary in images other than the one used to draw it.



The best way to get accurate topo-points is to:

- Choose images that have good contrast and no blurring.
- Choose images that are not among the first two images and not among the last two images.

The principal region in the Topo-Surface is visible in four images at least.

Points which lie close together in the image of the principal region must also lie close together in the 3D, e.g. in this case the topo-surface on the left image should not include both points but be split into two topo-surfaces.



6.5.7 Working with the Ruler Tool

1. To measure the distance between two measured points, select the Ruler icon.
2. Click on two points and the distance between them is shown in the “Ruler” dialog box. Points may be control points or new points. Three distances are provided:
 - Vertical distance
 - Horizontal distance
 - Slope distance

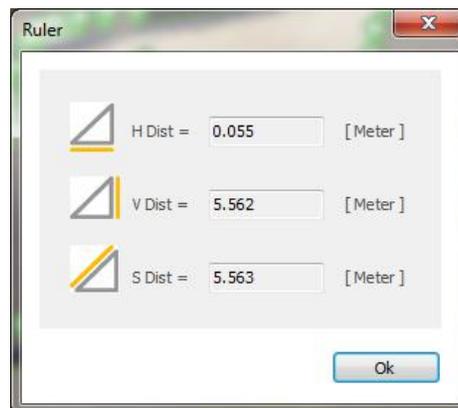


Figure 68: “Ruler” Dialog Box

6.5.8 Other “Measure & Draw” Window Properties

6.5.8.1 Show Control Point Projections

To show selected Ground Points projections, check the projections check box on the upper right corner and follow the procedure explained in section 6.4.1.3 above to select what Ground Control Points will be projected. FCP’s and Distances may not be

projected. The Projections window here has a bottom part that you can simply ignore for this purpose.

6.5.8.2 Show Names

Check or uncheck the “Names” checkbox to show or hide the point and projection names on the images.

6.5.8.3 New Point Projections

There are two types of New Points Projections as follows:

Both types are explained below.

Same cluster projections:

1. The new point projection is displayed as a small red square. The projection appears when any new point is marked on at least three images, but not on the current image.

New point mark can be added by clicking on a new point projection when in edit mode. After clicking on the new point projection, the new point projection (red square) will disappear.

2. Epipolar line is a hint of the new point location on current image when this point is marked only on one image (not on current image)
3. Epipolar circle is a hint of the new point location on current image when this point is marked on at least two images (not on the current image)

The figure below shows an example of new point projections in the same cluster. A polyline of 2 points was added in one image. One point was found in at least 3 images so it is shown as a red square projection, while the second one was found only in 2 images so it is shown as an Epipolar circle.

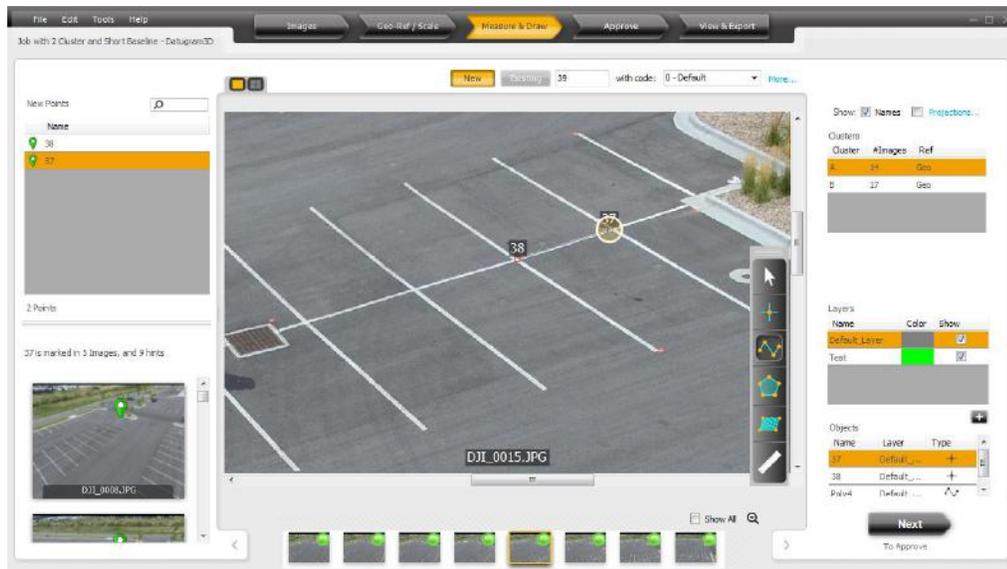


Figure 69 - New Point projection in same cluster

Cross Cluster Projections

1. Both clusters must be Geo Referenced
2. The user turns projections on and checks the cluster he/she wants projected on other clusters by clicking on the “Projections...” link and selecting the clusters in the bottom half of the expanded Projection Settings window shown below.

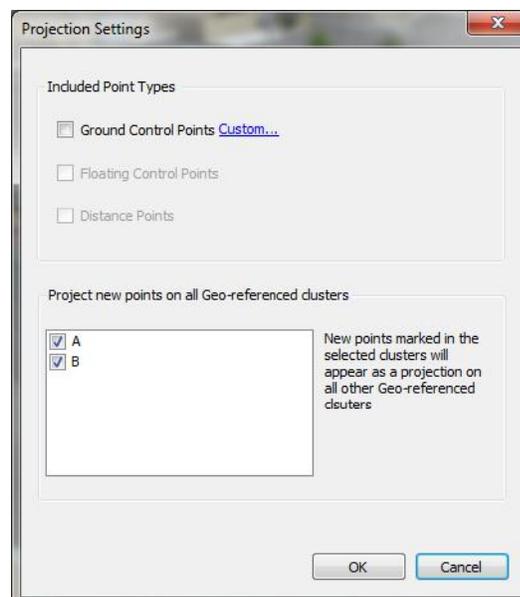


Figure 70 - Expanded Projections Settings Window

- The new point drawn on an image in one cluster is displayed as an orange square on other clusters. See Figure 71 below showing two points projected from another cluster and 2 points projected from the same cluster.

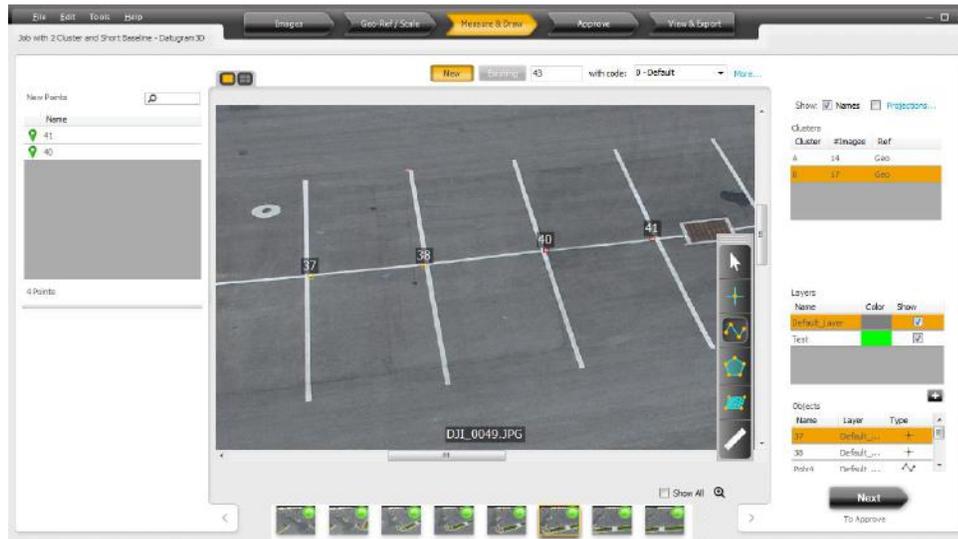


Figure 71 - New Point Projection on other clusters

- The user will be able to snap onto any of the orange projections using the Ctrl button while adding new objects other than single points. New points will not be added at points projected from other clusters, hence in the 3D viewer in View & Exports objects using cross cluster points will not be shown unless you show both clusters.

6.5.8.4 Creating polygons and polylines from existing points

There are two types of New Points Projections as follows:

New Points Projection in the same cluster – These are automatic projection.

Cross Cluster New Point Projections – These are projections of new points between Geo-Referenced clusters that the user has control over which clusters' new points will be projected on the remaining ones.

6.6 Step 4: Approve – Reviewing, Correcting and Approving Marked Points

The “Approve” window is used to review and correct a job’s measurement points. Information about the reliability and accuracy of the points is presented in tabular form. This screen provides tools to search, sort and filter the points. You can view each point on all the images in which it appears, correct the locations of new-point entities or delete new points and topo points.

6.6.1 Approving New Points

The coordinates of all new points and their measurement accuracy are automatically calculated when the “Approve” window is accessed. The coordinates and error ellipses of the control points appear in the table in the left pane. When a point is clicked on, all associated thumbnails are displayed (Figure 72). You can move the location of new-point markings to improve accuracy.

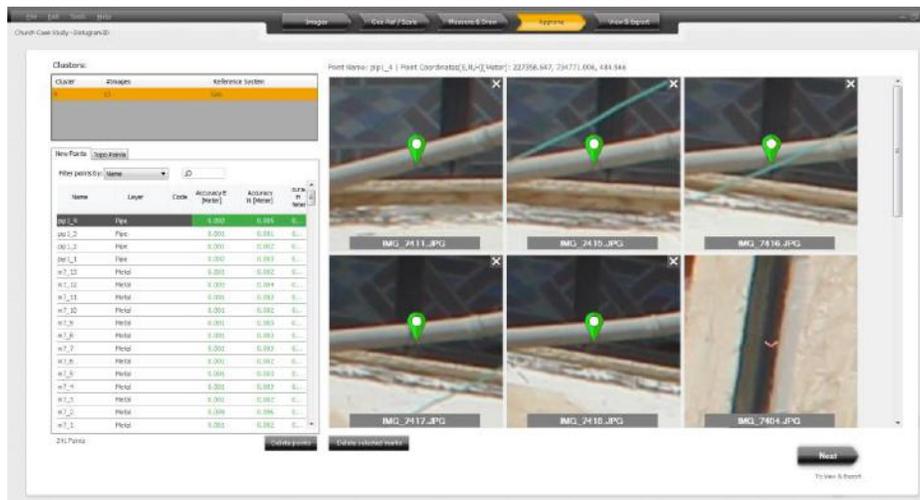


Figure 72: “New Points Approve” Window

6.6.2 Approving Topo Points

The coordinates of all new topo points and their measurement accuracy are automatically calculated when the “Approve” window is accessed. The coordinates and error ellipses of the topo points appear in the table in the left pane. When a point is clicked on, all associated thumbnails are displayed (Figure 73).



Topo-point locations cannot be edited.

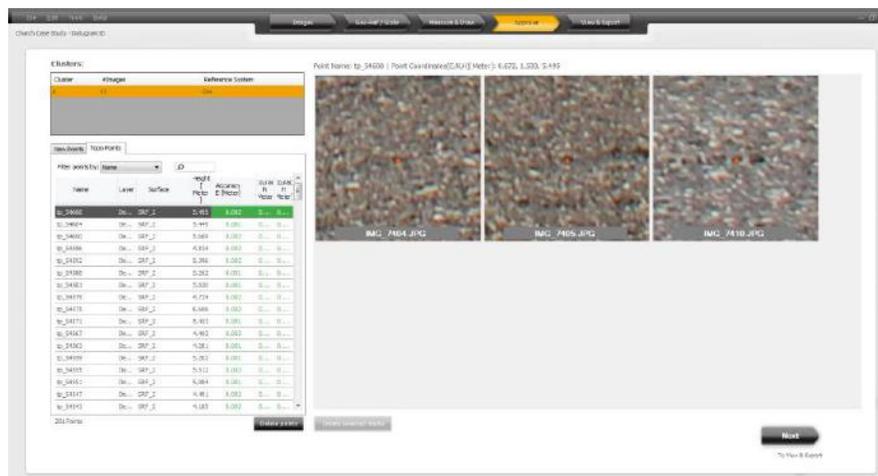


Figure 73: “Topo Points Approve” Screen

6.6.3 General Approval Guidelines

The error ellipses of the measurements are presented in metric units. DatuSurvey™ is pre-configured as follows:

- Measurement errors smaller than 3 cm are colored green.
- Measurement errors of 3 to 4 cm are colored yellow.
- Measurement errors larger than 4 cm are colored red.

These parameters are configurable by the user using the Tools/Settings in the Accuracy Display tab.

Measurement errors may be caused by (1) the point not being accurately sampled in the images, (2) the distance of the point from the camera is too great, or (3) there is an error in the software automation algorithms. To verify that the point is accurately sampled in the images:

1. Click on the desired point in the table in the “Approve” window.
2. Browse through the different images to view where the point was sampled and correct it as required. Images can be zoomed so it is very simple to achieve very accurate positioning on the “Approve” window.
3. To delete one point, click on the line to highlight it and then click **“Delete points”**.
4. To delete several points, right click on the lines to be deleted, one after the other, to highlight them and then click **Delete**.
5. Displayed points can be filtered by selecting one of the following criteria and typing the name of that criterion.
 - New points can be filtered by name, layer name or code.
 - Topo points can be filtered by name, layer name or topo-surface.
6. If a specific point is inaccurate or erroneous, it can be deleted. To delete a single mark, click on the image and then click on the **X** (window closing) or on the **Delete Image**

Marks button. To delete several marks, hold the **Control** key and click on several image windows, then click on **Delete Selected Images**.

6.7 Step 5: View & Export – Previewing and Exporting to Exchangeable Formats

In the “View & Export” window you can view all surveying map data created and collected by DatuSurvey™. In this window you can create the final output as a text file, a PDF file or a DXF file. In addition, you can manage the content of the export by selecting the desired exported layer, control points (used, all, or none) and which layer is used to create the mesh in the 3D Model window.

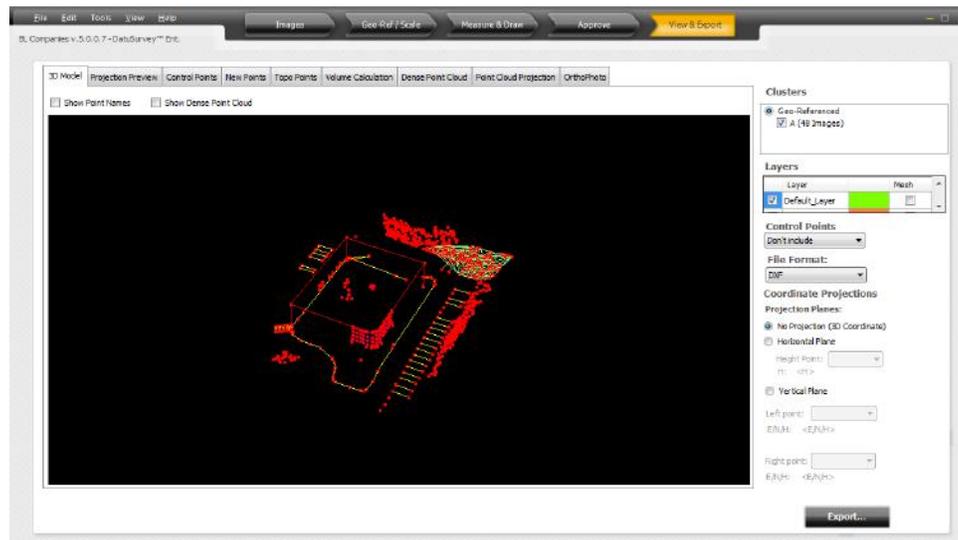


Figure 74: “View & Export” Window

The application provides views and information of the project from different perspectives:

- **3D Model:** Displays a 3-dimensional view of the selected layers. The colors of the objects displayed in the 3D Model are in accordance with the colors of the layers. This window has the following functionality:
 - Hovering over a point shows the point name.
 - Showing point names checkbox which allows you to hide or display the names of all measurement points.
 - Overlaying the dense point cloud, if available, over the drawing. This does not affect the DXF export option at all.
 - Clicking and holding the mouse’s right button to pan over the view.
 - Using the mouse wheel to zoom in and out.
 - Clicking and holding the mouse’s left button to rotate the view.

- Note: We may encounter some false positive points in our job. We can fix the false positive issue by moving the point marks manually in "Approve" window or by selecting images one by one in "Measure & Draw" tab.



Sometimes the lines fail to appear when polygons or polylines are marked by snap to control point projections. To rectify this situation, select "Show all points" in the Control Points combo box.

- **Projection Preview:** Presents a top-down view of the entities-to-be-exported, reflecting the vector-projection which has been set. If no-projection has been selected, nothing is shown. This window also provides panning and zooming.
- **Control Points:** Gives a list-view of all control points positions and residuals in meters.
- **New Points:** Gives a list-view of all selected new points.
- **Topo Points:** Gives a list-view of all selected topo points.
- **Volume Calculation:** Provides ability to calculate volume concealed in measured structures.



Volume calculation requires that either Geo-Ref or Scale cluster to be selected. It won't work on a 3D model without any scaling property.

- **Dense Point Cloud:** Available only in the Enterprise Package. It allows generation a dense point cloud if not previously generated, and manipulation the dense point cloud in a 3D viewer. It also allows exporting the Dense Point Cloud to .PLY, .LAS, or .DXF files. See figure below.

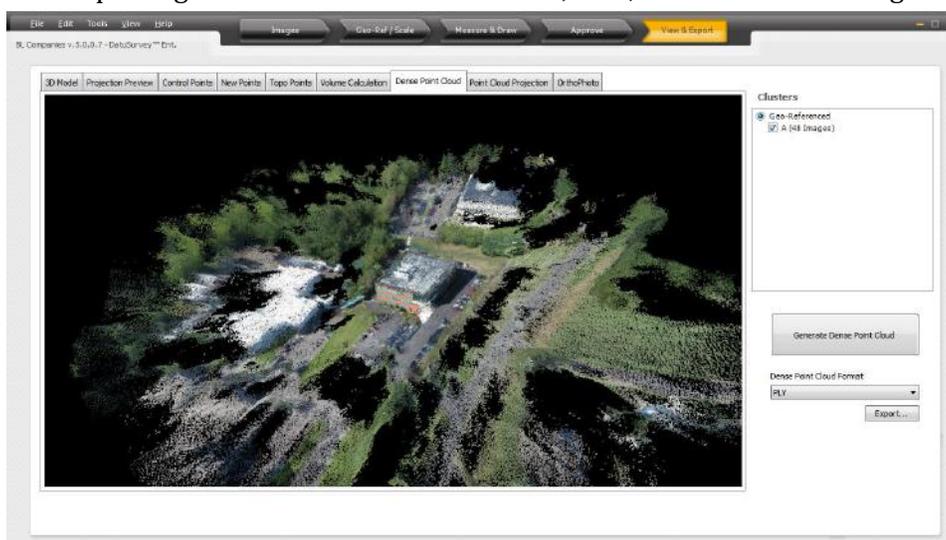


Figure 75 - Dense Point Cloud

- **Point Cloud Projection:** Available only in the Enterprise package and it allows the projection selected dense points form the 3D cloud on a 2D surface and saving it to .DXF or .PLY file formats. See figures below:



Figure 76 - Point Cloud Projection

You may adjust the boundaries of the area you would like to project by stretching the shown rectangles on the 3 views. You may also rotate the cloud itself clockwise or counter clockwise using the arrows available for that on the bottom right corner of the top view. Once the area is selected you may press the “**Project Point Cloud**” button which will show the top view projection. You may save or discard the projection. If you select to save it, you will be prompted to select one of more views out of the six sides of the cube to save, and all selected views will be saved in .PNG as well as .PLY formats in the selected folder.

- **Orthophoto:** Available only in the Enterprise package and it allows the generation of an orthophoto of a cluster. The result will be saved in a tiled tiff format in a folder that has the name of the cluster.

6.7.1 Exporting Job Data

To export the measurements as final output files or as input to CAD software for further processing, in the right pane, perform the following steps:

1. Select the layers to be included in the export by using the checkboxes to the left of the layers’ names.
2. Select which layers to mesh, by using the checkboxes to the right of the layers’ names.
3. Select which control points to include in the export (none, just the used control points or all the control points).
4. Select the output file format: **DXF, ENH, NEH** or **PDF**.
5. Select the projection:

- a. No projection.
 - b. **Horizontal plane** – set the H value of the horizontal plane. You can type a specific value or set the height by selecting a new point from the list so its height will set the horizontal plane of reference.
 - c. **Vertical plane** – sets a plane, perpendicular to the horizon, which passes through two selected new points. All measurements, then, undergo vector-projection.
6. Click **Export**.



Management of data in the “View & Export” window does not alter the data stored by DatuSurvey™. Changes are made only for preview and export.

6.7.2 Volume Calculations

6.7.2.1 Background

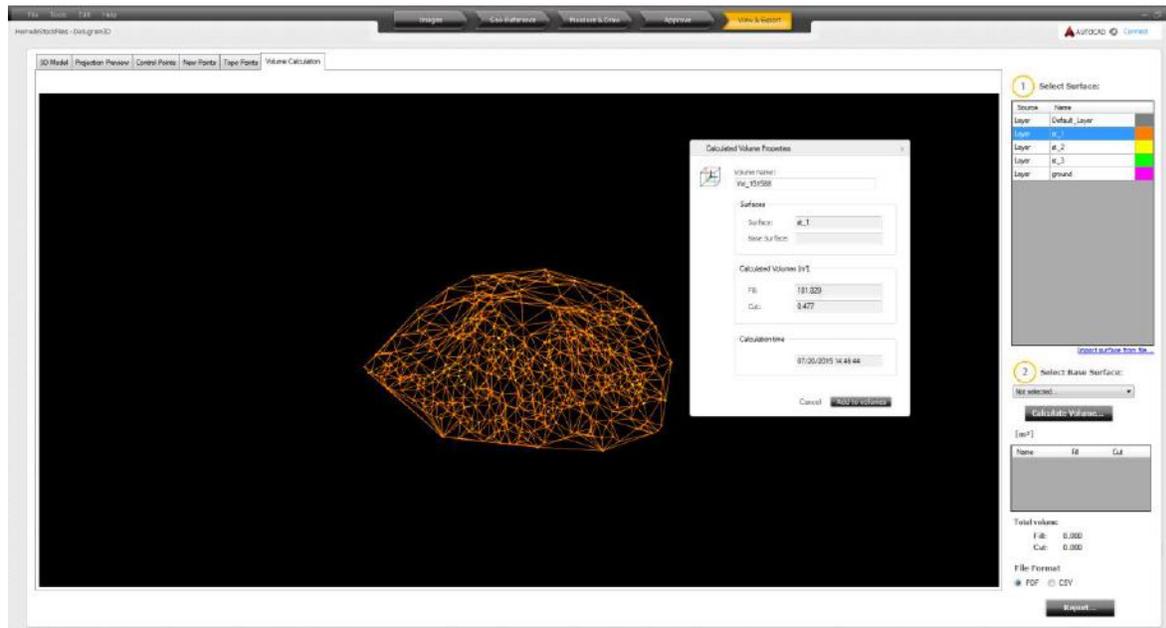


Figure 77: The “Volume Calculation” Window

The “Volume Calculation” window (Figure 77), in the “View & Export” window, is a tool which is used to calculate volume of material enclosed within a relief structure. This is useful in construction works, earth works, tunneling and mining, where large quantities of soil have accumulated or are planned for excavation and measuring of such an aggregation is necessary.

Volume calculation is done based on one or two surface objects. In the first case, DatuSurvey™ creates a convex hull, a virtual surface enclosing the given physical surface. Then, calculation of the volume enclosed between the physical surface and the convex hull is performed. In the

second case, DatuSurvey™ calculates the volume of material enclosed between two given physical surfaces.

In the current version of DatuSurvey™, in order to calculate a volume, the base surface must fully include the selected surface (Figure 78).

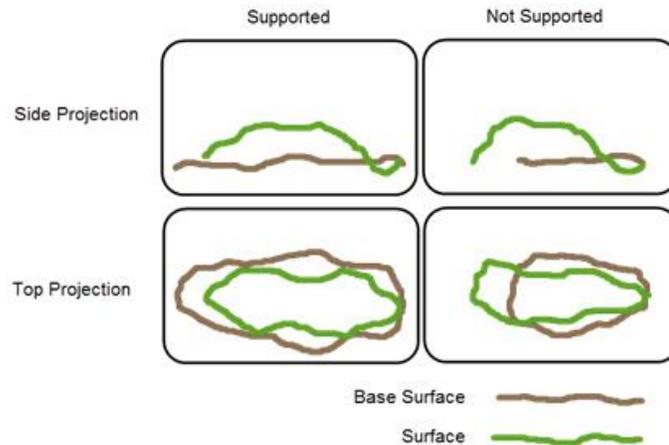


Figure 78: Supported Surfaces Geometry

6.7.2.2 Usage Flow

To calculate volumes perform the following steps:

1. Populate the “Surfaces” list with at least one Surface object. If the current job already has a Layer object containing measured points, they will automatically be converted to Surface objects and be displayed in the “Surfaces” list and in the “Base Surfaces” dropdown list.
2. Surface objects can also be added by importing points from an XYZ file. Click on **Import surface from file...** The “Import Surface from File” window (Figure 79) opens.
3. Browse to the required points XYZ file, parse the point lines as needed and click on Import. The “Import Surface from Point File” window closes and the “Add Surface” window (Figure 80) opens.
4. Type a name and description for the new surface (by default the surface will get the file name) and set the surface color (by default the color will be as different as possible from the colors of the existing surfaces).
5. Click **OK**. The file’s points will be imported to the new Surface object.

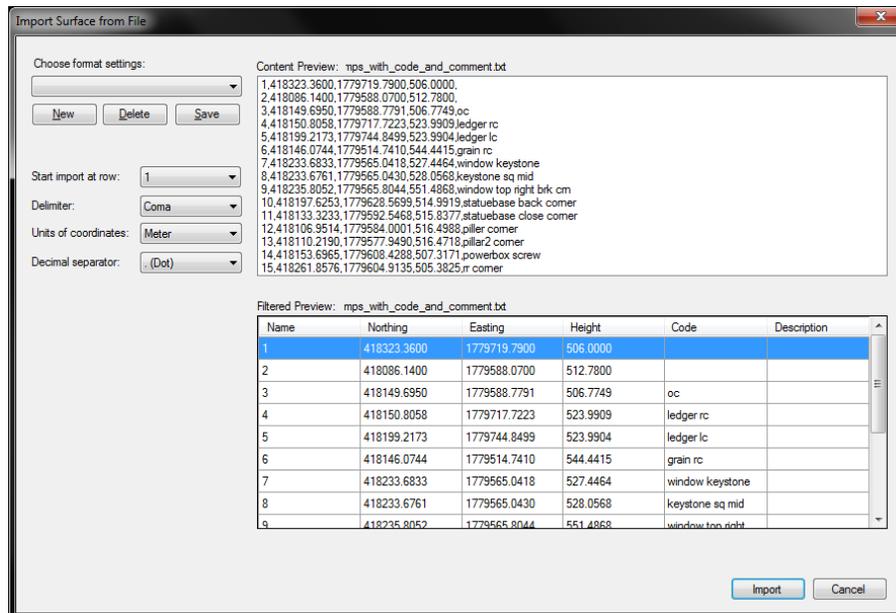


Figure 79: Import Surface from Points File Window

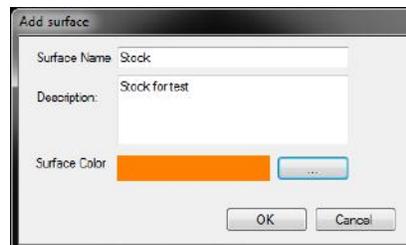


Figure 80: Add Surface Window

6. In the “Surfaces” list, using the checkboxes in the left column, check the surfaces to be displayed (Figure 79). Revise them and determine if they are ready for volume calculation.
7. The following user interface controls can help during the visually scanning of the surface prior to calculating the volume.
 - If a point is identified as erroneous, it can be deleted by performing the following steps:
 - Hover over the point; the point name is displayed.
 - Zoom in to the point.
 - Right click on the point.
 - Click on Add to **Delete Queue**, if this is the first point you mark for deletion the will also open the “Delete Points” dialog, where you can see and edit what you plan on deleting.
 - Once you are done Click on the “Delete Points” button to delete all points in the list. See figure below



Only Topo-points can be deleted. New points may be deleted from the “Approve” tab.

- If the surface is not accurate go to the “Measure & Draw” window in order to draw more topo-surfaces or to add new points where needed.

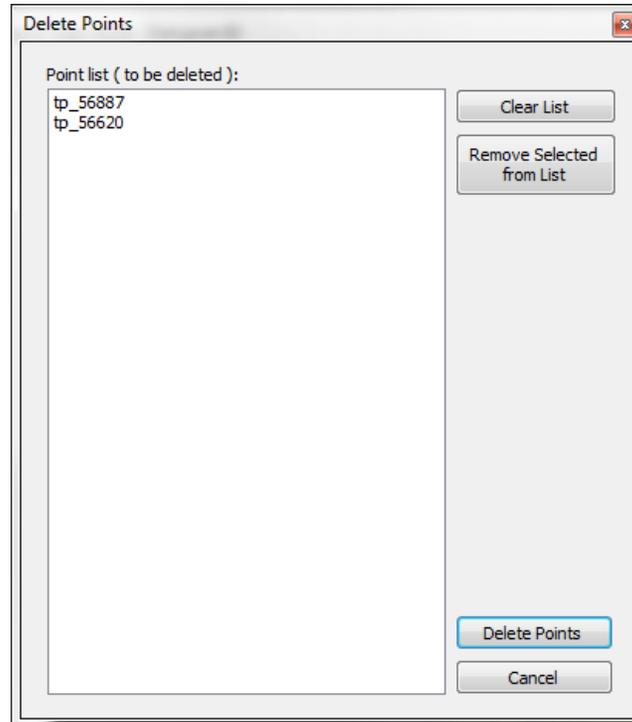


Figure 81: Deleting the Selected Points

8. After a surface is selected (from the “Surfaces” list), click on the **Calculate Volume** button or add a base surface from the “Base Surfaces” list to the calculation and then click **Calculate**. The surface volume is calculated and displayed in the “Calculated Volume Properties” window (Figure 82).

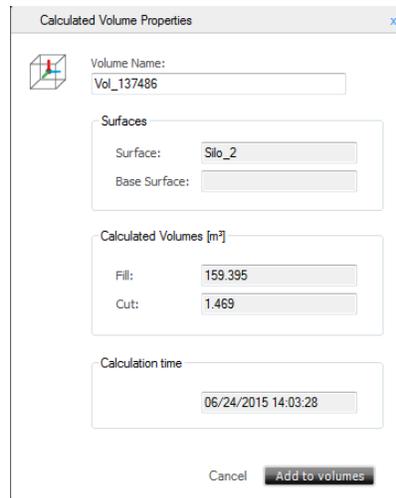


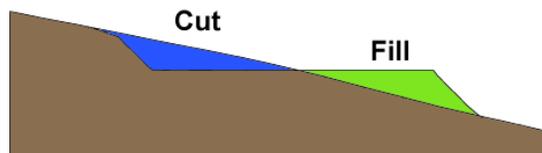
Figure 82: Calculated Volume Properties Window



If only one Surface is used for the volume, the “Calculated Volume Properties” window shows the surface used for the volume calculation. If two surfaces (surface and base surface) are used for the volume calculation, both surfaces will be displayed in the window.

The window shows the Fill and Cut calculated values in the measuring unit used throughout the job (m³ or ft³).

Throughout this document:



“Fill” refers to the amount of material accumulated above the base ground level.

“Cut” refers to the amount of material subtracted below the base ground level.

9. To name the volume, as it will be seen in the “Volumes” list, in the “Calculated Volume Properties” window add a name. The calculated volume can be added to the “Volumes” list by clicking **Add to Volumes**. The volume is added as a new record to the list of volumes.
10. When all volume calculations are completed and added to the “Volumes” list, a volume report can be exported. Two types of file formats can be exported: PDF and CSV. From the “Export File Format” section, select the desired format and click **Export....**



DatuGram3D Volume Calculation Report

Job Name	HorrodsStockPiles
Organization Name	
Creation Date	2015-07-26 16:18
Measurement Unit	[US Foot ³]

Volume Name	Pile1
Surface Name	st_1
Surface Description	
Base Surface Name	
Base Surface Description	
Calculation Date & Time	2015-07-26 16:16
Fill Value	226761.057
Cut Value	595.280

Volume Name	Pile2WithGroundBase
Surface Name	st_2
Surface Description	Pile 2 Surface
Base Surface Name	ground
Base Surface Description	Ground Base Surface
Calculation Date & Time	2015-07-26 16:16
Fill Value	306380.995
Cut Value	1243.600

Total Fill Value	533142.052
Total Cut Value	1838.880

Figure 83: Volume Calculation – PDF Report

6.7.2.3 Other Possible Actions

The following functions can also be utilized to enhance volume calculations.

- **Changing Surface Properties:** Right click **Surface** in the “Surfaces” list to access its context menu. Select **Properties**. The “Surface Properties” window opens. In this window you can modify the Surface name, description and color.

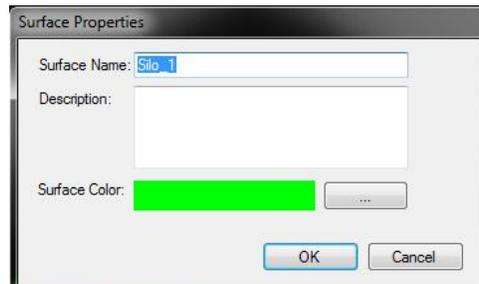


Figure 84: Surface Properties Window

- **Exporting Points Collection of a Surface:** Right click **Surface** in the “Surfaces” list to access its context menu. Select **Export to Points File....** A window opens. Here you can define the file location and name, and a file is saved in ASCII format with XYZ coordinates.
- **Changing Volume Properties.** Right click **Volume** in the “Volumes” list to access its context menu. Select **Properties...** The “Calculated Volume Properties” window opens. Here you can modify the volume name.

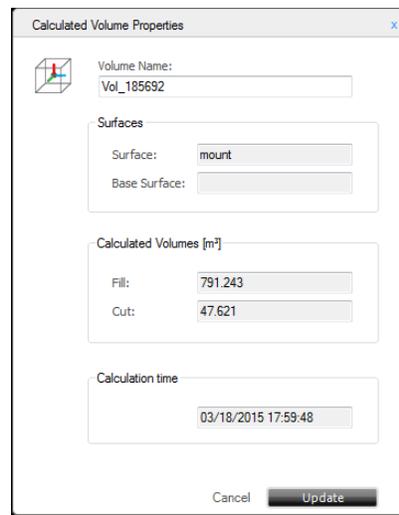


Figure 85: Calculated Volume Properties Window

- **Recalculating Volume.** Right click **Volume** in the “Volumes” list to access its context menu. Select **Recalculate....** This option let you update the volume value in the event that one of the surfaces involved has been changed. The “Volume Recalculation Properties” window opens letting you view the changes in the volume values. You can decide whether to update the value for Volume or leave it as is. The date and time where the last calculation was made is also displayed.

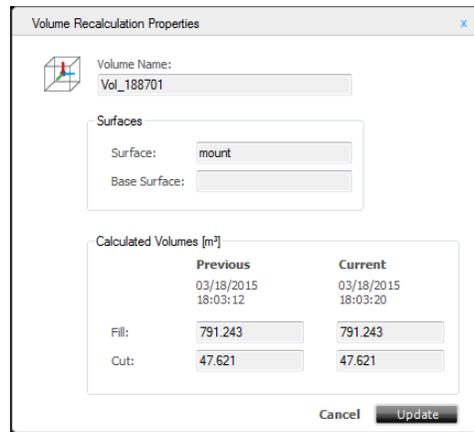


Figure 86: Volume Recalculation Properties Window

- **Removing Surface from “Surfaces” List:** Right click **Surface** in the “Surfaces” list to access its context menu. Select **Remove**. If the Surface is based on a Layer, this menu option will not be displayed. Only surfaces based on a points file can be deleted.
- **Removing Volume from “Volumes” List.** Right click **Volume** in the “Volumes” list to access its context menu. Select a particular volume and then click **Delete**. The volume will be removed from “Volumes” list.

7 DatuSurvey™ Menu Options

This section explains some of the menu options when their use is not self-explanatory or were not explained previously in this document.

7.1 File Menu

7.1.1 Save as...

Saves the current job under a new name and continue to work with the newly saved job. This means that the current job will stay as it was after the last save, and if new changes were made after the last save they will be in the new job

7.1.2 Export

Similar to the Save as except that the current job is saved under a new name with all changes up to the moment the Export job was done, but the system continues to work on the current job.

7.1.3 Close & Archive Job

Similar to the “Close Job” except that it does also a temporary file cleanup to free disk space. This option should be used when you know you are done with this job. “Close Job” does not clean up temporary file, hence opening the job next time will be faster that after “Close & Archive Job”.

7.2 Tools Menu

7.2.1 Settings Window

The Settings windows provide control over basic configuration settings for DatuSurvey™.

To access the Settings windows, click **Tools > Settings**.

7.2.1.1 General Settings

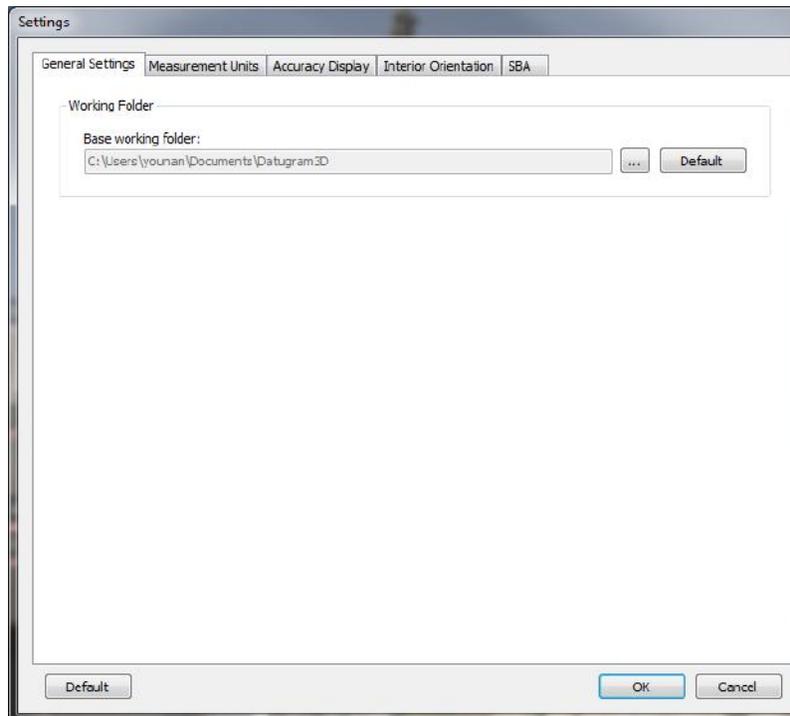


Figure 87: The “General Settings” Window

In the Working Folder set where DatuSurvey™ stores its temporary data. In order for DatuSurvey™ to work as expected, its working folder should be located on a local drive (SSD is preferred), not on network drive.



In some computers associated with networks, it is common for folders that contain users’ documents to reside on network storage by default. For regular documents (word processing, working sheets, etc.) this is quite acceptable but it will not foster effective work with DatuSurvey™. DatuSurvey™ performs a vast number of image and mathematical processing and needs a fast storage device. Only local storage devices can provide sufficient performance results. Because of this, it is recommended that the DatuSurvey™ working folder resides on a local drive. An SSD is recommended.

7.2.1.2 Measurement Units

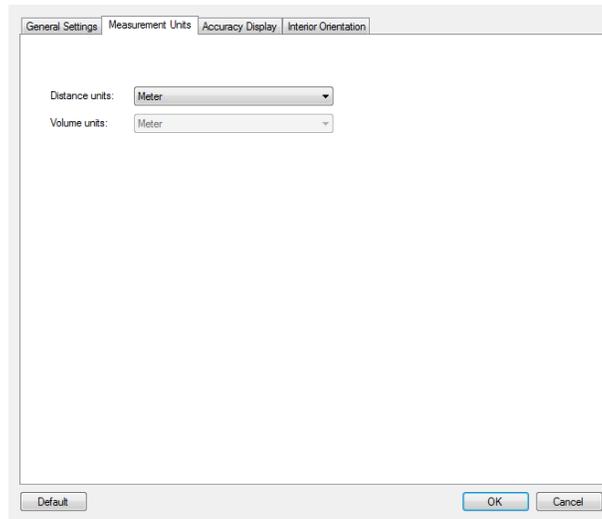


Figure 88: The “Measurement Units” Window

In the “Distance units” dropdown box, the following measurement units can be selected:

- Meter
- US Foot
- International Foot
- Yard

In the “Volume units” dropdown box, the following measurement units can be selected:

- The distance units "Meter" can work with volume units of “Meter” only
- The distance units "US-Foot" can work with volume units of either “US-Foot” or “Yard”
- The distance units "Int. Foot" can work with volume units of either “Int. Foot” or “Yard”

Click **OK** to set the measurement unit for the whole job.

7.2.1.3 Accuracy Display

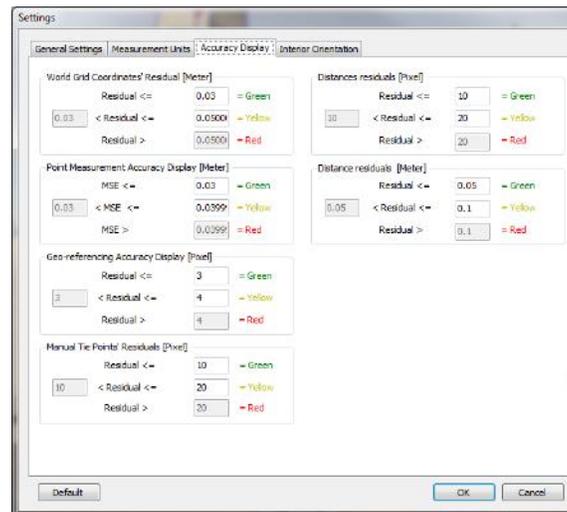


Figure 89: The “Accuracy Display” Window

Set the range of residual measurement errors (green, yellow or red) as displayed in the Quality Control report (as a fraction of meters).

7.2.1.4 Interior Orientation

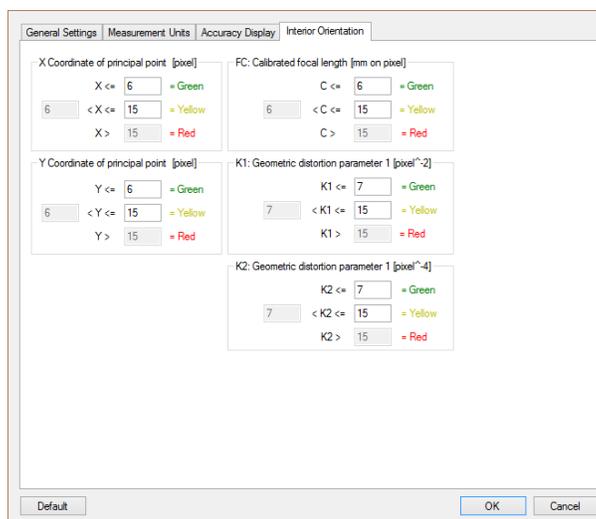


Figure 90: “The Interior Orientation” Window

Modify the information in this table in order to change measurements used by DatuSurvey™ to establish residual values.

7.2.1.5 SBA

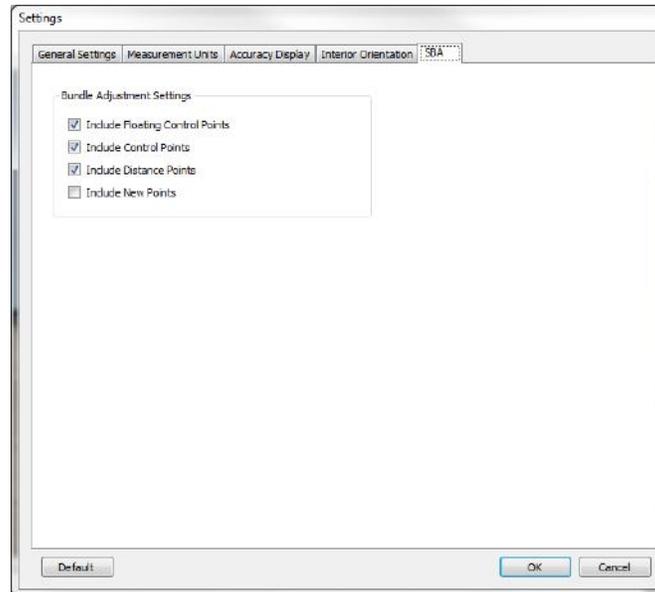
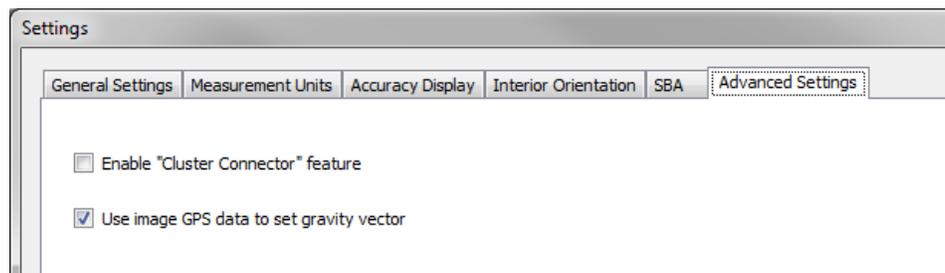


Figure 91: "SBA" Window

Modify what points will be used in the SBA (Sparse Bundle Adjustment) calculation when the Apply button is pressed in the Geo-Ref / Scale window. It is very important to be very careful when setting these options as it will improve the accuracy of the model, but it may slow the process of calculations.

7.2.1.6 Advanced

This tab is used to set advanced software options as shown in the figure below.



7.2.2 Managing and Using Codes and Blocks

Codes and blocks are attributes of map entities used in most common surveying CAD software.

7.2.2.1 Managing Codes

Code is metadata associated with a map entity that relates it to a specific family of entities. For example, code could indicate that a specific new-point entity is part of the entities related to mapping window frames or semaphores. A code has a name and a description. Each map entity can have only one code.

In DatuSurvey™ each new-point entity has an associated code. By default, a new point has the code named “0” with description “Default”. You can change the new-point code to one of the codes that exist in the job’s codes library. In order to have codes in the codes library, you must load its commonly used list of codes from the job.

7.2.2.2 Working with the “Point Codes Library” Window

1. To access the “Point Codes Library”, click **Tools > Point Codes Library**.

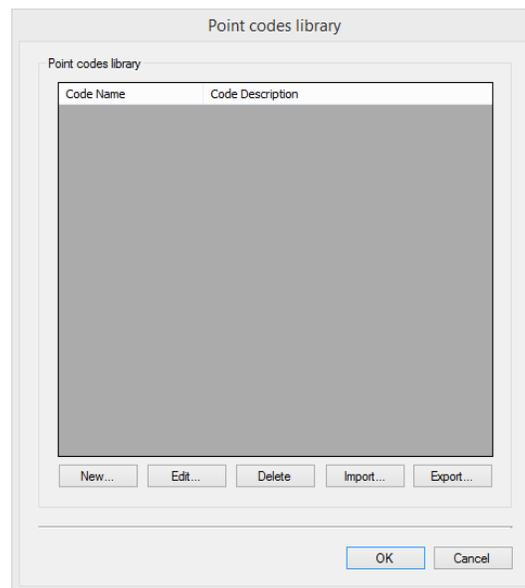


Figure 92: “Point Codes Library” Window

2. The following functions are available: importing a codes library file, exporting a job’s codes to file, creating a new code, editing an existing code or deleting one.

7.2.2.3 Importing Codes Library File

1. Click **Import**.
2. Select the codes library text file. The figure below shows an example of an importable point code text file.

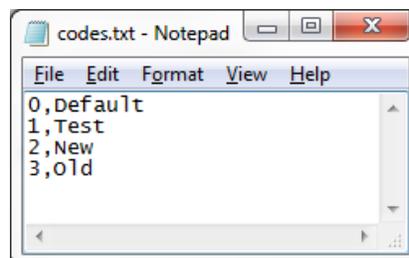


Figure 93 - Point Code File

3. Confirm the import.

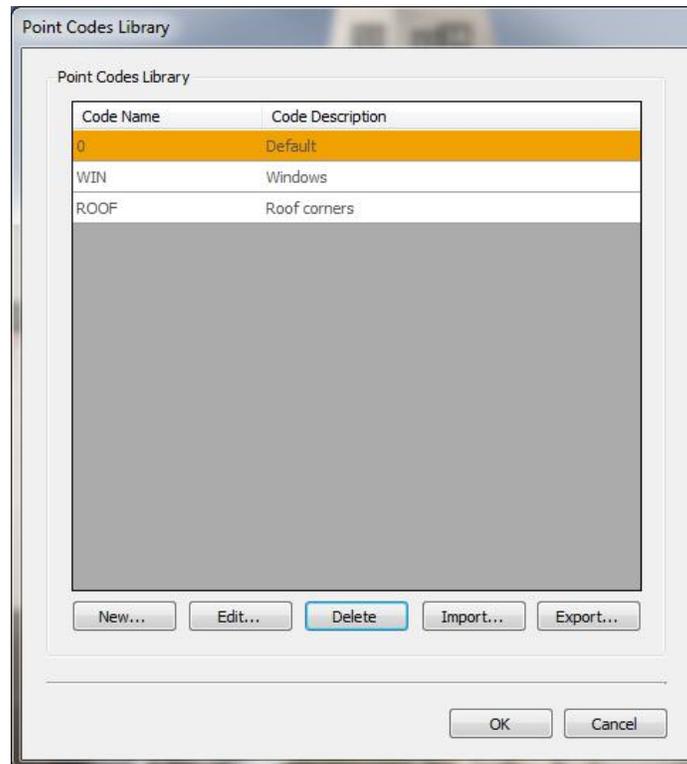


Figure 94: Point Codes Loaded from Codes Library File



If the system encounters names of existing codes, the “Naming Conflict” dialog box offers options to skip, rename, or overwrite the point.

7.2.2.4 Exporting Job’s Codes to a Text File

1. Click **Export**.
2. Type the name of the file to hold the exported codes library. Output file format will be as shown in Figure 93 above.
3. Confirm the export.

7.2.2.5 Creating new Point Code

1. Click **New**.

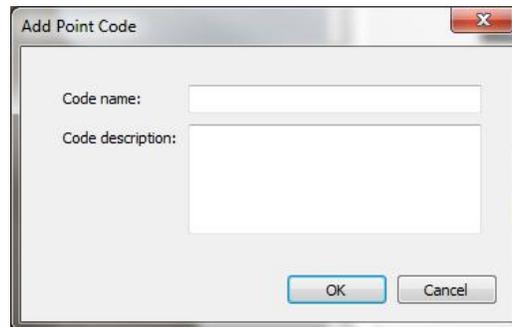


Figure 95: “Add New Point Code” Window

2. Type the name and description for the new code.
3. Click **OK**. A new point code is added to the job’s codes library.

7.2.2.6 Editing an Existing Point Code

1. From the point codes list, select the code you wish to change.
2. Click **Edit**.

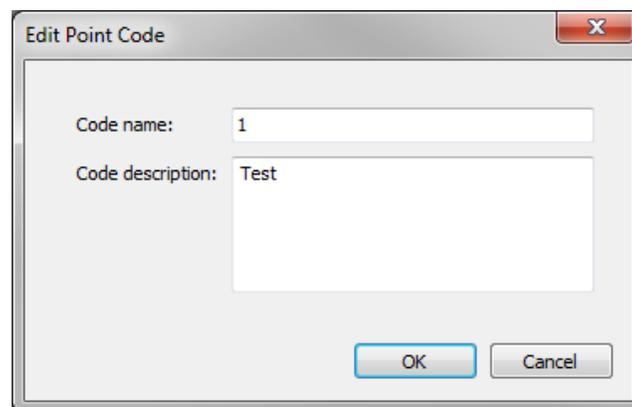


Figure 96: Edit Existing Point Code – Edit Point Code Window

3. Edit the name and/or description of the code.
4. Click **OK** and the changed code values are saved.

7.2.2.7 Deleting an Existing Point Code from the Job’s Codes Library

1. From the point codes list, select the code you wish to delete.
2. Click **Delete**.

7.2.2.8 Using Blocks

A Block is the unit used by surveying software applications to store metadata associated with mapping entities and the graphical symbol representation of the entity. Thus, a block is a data

structure that combines an icon and metadata attributes. In DatuSurvey™ blocks are used when the surveying map is exported to DXF format.

Each new-point entity is associated with a block that has the same graphics symbol and the following attributes:

Attribute Number	Attribute Name	Attribute Data Type
1	Point Name	text
2	Point Comment	text
3	Code Name	text
4	Code Description	text
5	North	double
6	East	double
7	Elevation	double
8	Accuracy North	double
9	Accuracy East	double
10	Accuracy Elevation	double
11	Measurement Unit	string

7.2.3 Client License Manager

This option is available only when network license is used. Using this menu option user will be able to borrow a network license that is not used by any user for a period of time, work with it offline, and return the license to the network server automatically when borrowing time elapses or by the user when done using it.



Borrowing and returning a license can be done only while no job is opened, so either you do it as soon as you start the application before opening a job, or close the job you are working on and then do it.

7.2.3.1 Borrowing a Network License

To borrow a network license select the menu option “Tools/Client License Manager” as shown below.

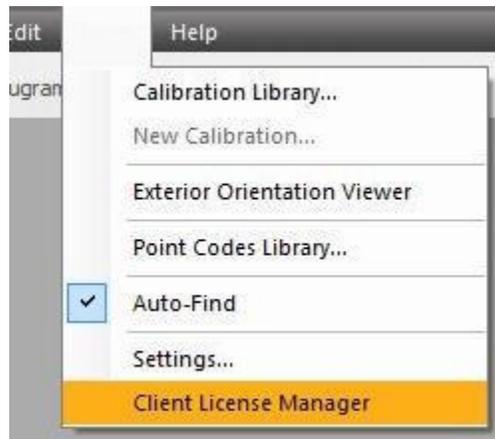


Figure 97 - Client License Manager

When option is selected, an external application will start and will show you a list of products that are available to borrow license for. See below

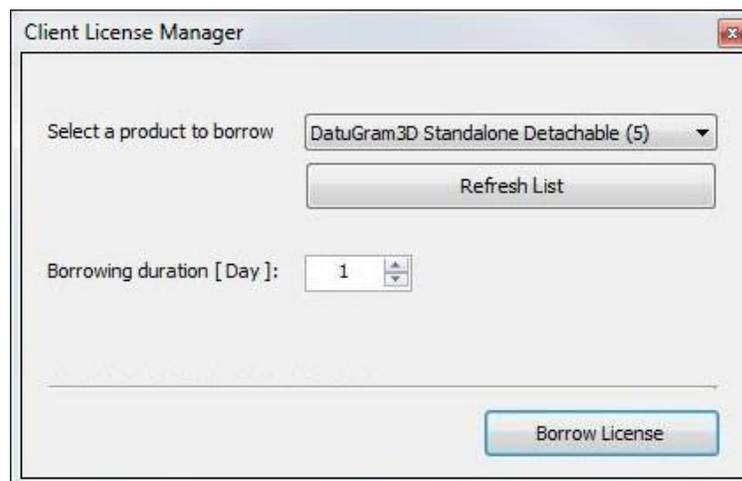
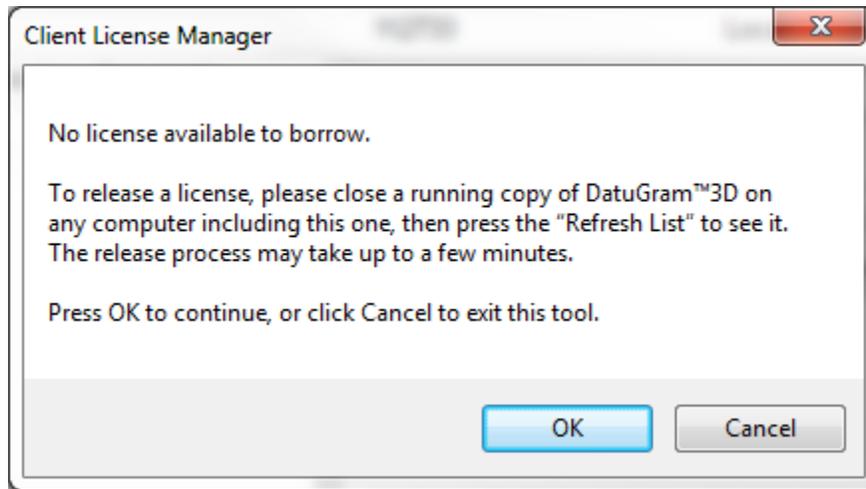


Figure 98 - Borrowing a Network License

If there are no license available at all to borrow the message shown below will appear, or if the product you are looking to borrow the license for (DatuSurvey™ in this case) is not in the list, you will need to quit the DatuSurvey™ application on one of the computer it is running on to release a license. The Client License Manager is a standalone application so it is okay to quit the DatuSurvey™ application running on the current computer. Once quitting the application on one computer, click on the “Refresh List” button to see the available products again. The release process may take up to a few minutes.



If there are available Datamate software licenses to borrow simply select the desired one, set the Borrowing time duration to any number of days from 1 to 14, and click on the Borrow License button. From this point DatuSurvey™ will be using a local borrowed license, and the license will not be available on the network for other users. If you set a borrowing duration time that takes you beyond the license expiration date, the expiration of the borrowed license will be set automatically to the license expiration date.

7.2.3.2 Returning a Network License

There are two ways a borrowed license can be returned and made available to other users as follows:

1. Automatically when the time set for borrowing period expires, regardless if the borrowing computer is connected to the network or not.
2. Manually by the user when he/she decides is done with it. This option requires running the “Client License Manager” in one of the ways described above, which will show the “Client License Manager” application with the return license options as shown below. Simply select the license you want to return from the dropdown list and click on the “Return License” button.

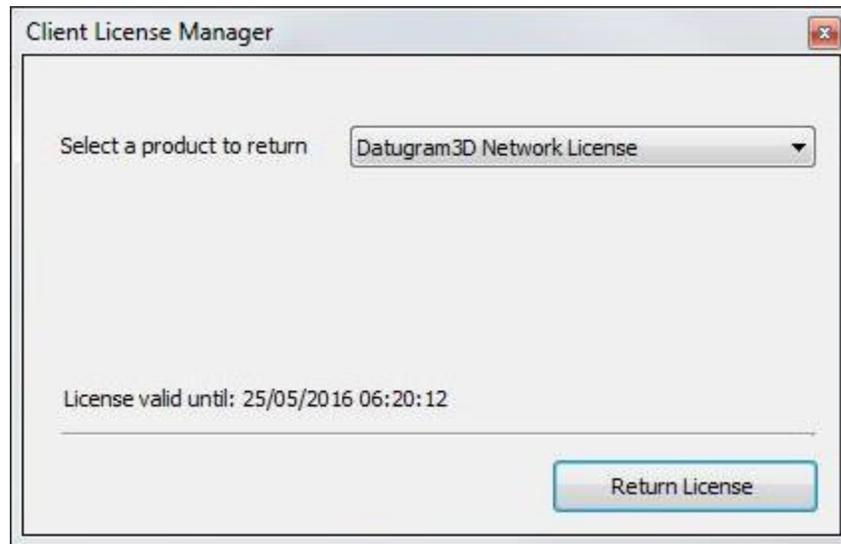


Figure 99 - Returning a Network License

The “License valid until” date that appears on the Return license window is the expiration date of the borrowed network license.

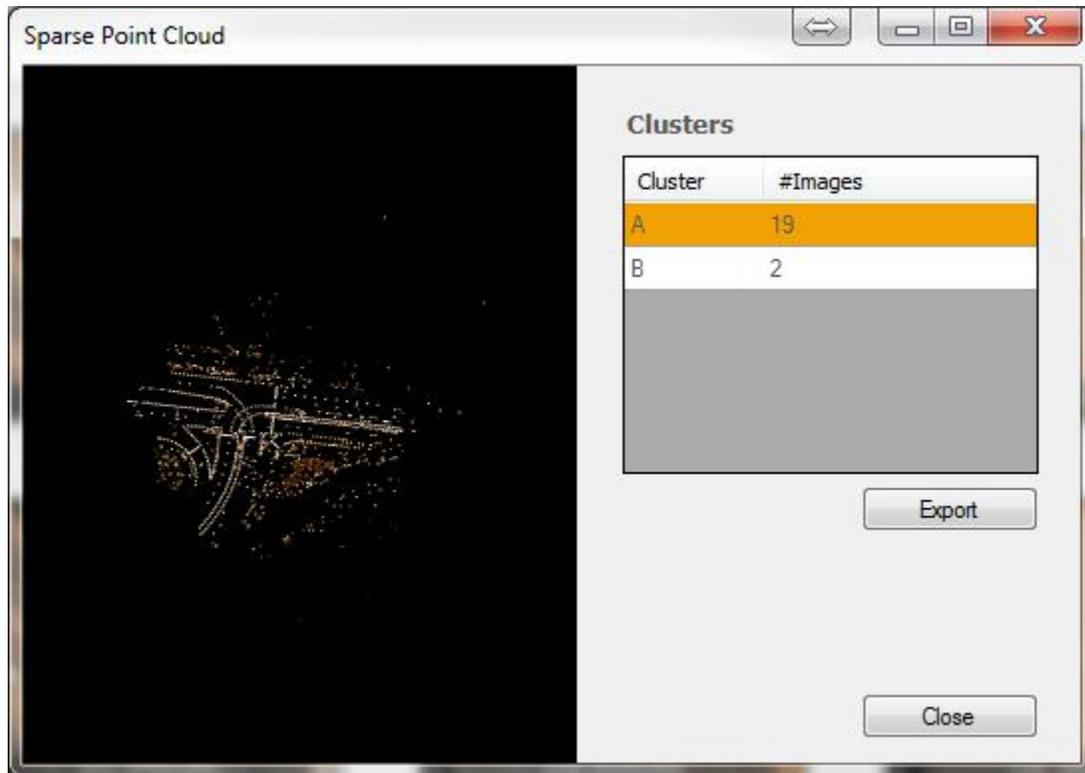
7.2.4 Generate Dense Point Cloud

When available, this option allows the generation of dense point cloud for all clusters. When Dense Point Clouds are generated they override any previously generated clouds.

7.3 View Menu

7.3.1 Sparse Cloud Point

The menu option allows you to open the Sparse Point Cloud display and allows you to move between clusters. See figure below.



Additionally, it allows you to export the points of any cluster to an external .ply file that can be opened using other software packages, such as “Cloud Compare” and MeshLab”.

7.4 Help Menu

The following sections present the main Help menu options.

7.4.1 About DatuSurvey™

Clicking on “About” opens the “About” window. This window shows the product Name, Version, License information, and other applicable messages. The window below appears if you have a valid perpetual license with a maintenance agreement expiration date more than 30 days away



Figure 100: About Window – Valid perpetual license

If you have a valid time-base license and the expiration is more than 14 days away, you will see the following window.



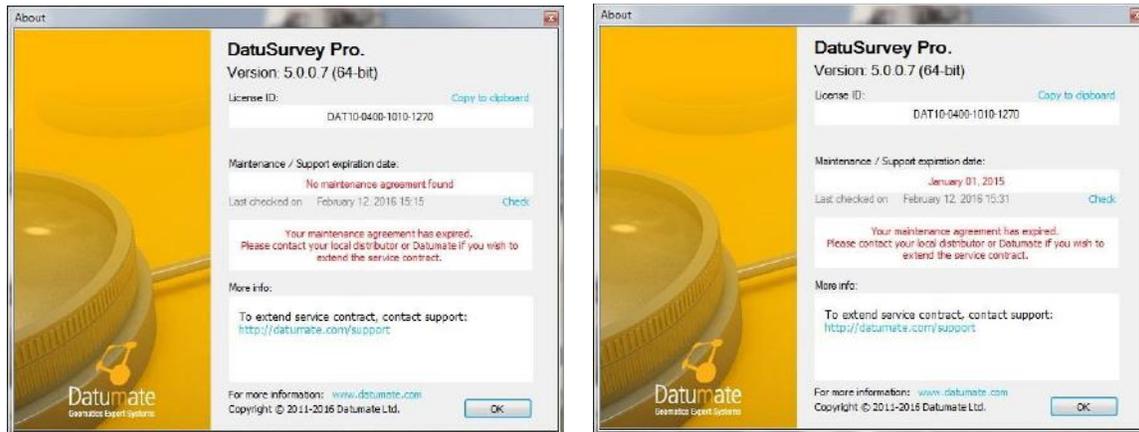
Figure 101: About Window – Valid time-based license

In other cases where you have a perpetual license and the maintenance agreement is about to expire, or you have a time-based license and the license is about to expire, the “About” window will give you a reminder of that; see below. These messages may also appear at startup when the automatic check for update is done, but will be labeled “Validate Maintenance” or “Validate License”.



If you have a perpetual license and the maintenance agreement date is not found or has already expired, the About window will notify you as shown below. These messages may also appear at

startup when the automatic check for update is done, but will be labeled “Validate Maintenance” or “Validate License”.



If you have a time-based license and the license has already expired, the About window will notify you as shown below. This is assuming that the license has expired while the software was already running.



If the time-based expiration was detected at startup, the system will show the message below and will not allow you to continue, unless you have a new license ID that you want to update, in which case you may press the “Update License” button and update the license ID and key.



Figure 102 – Expired License Message

7.4.2 Checking for DatuSurvey™ Software Update

Click on Check for Update, so that DatuSurvey™ will communicate with Datamate’s server to look for a newer version of the application.

1. If a new version is found and you have a valid maintenance agreement, DatuSurvey™ will inform you that a newer version exists and it can be downloaded (Figure 103). Follow instructions to download and save the installation file. After installation file is downloaded, the installation starts automatically.

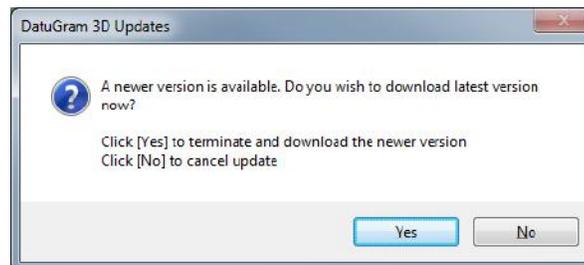


Figure 103: Software Update Window

2. If a new version is found and you do not have a valid maintenance agreement, DatuSurvey™ will inform you that a newer version exists and it can be downloaded (Figure 104).

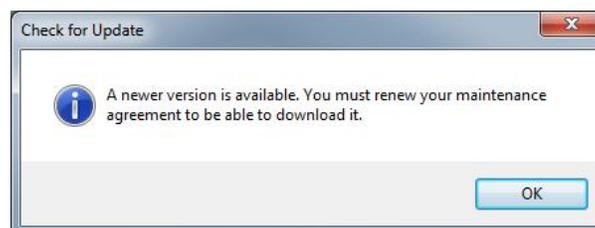


Figure 104: Version Available but no Maintenance Agreement Message

3. If the most recent version is installed, an appropriate notification is displayed (Figure 105).

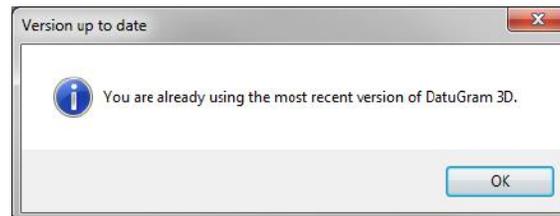


Figure 105: Version Up-to-Date Message

7.4.3 Opening the Welcome Screen

1. Click on **Welcome Screen** to open the Welcome window.

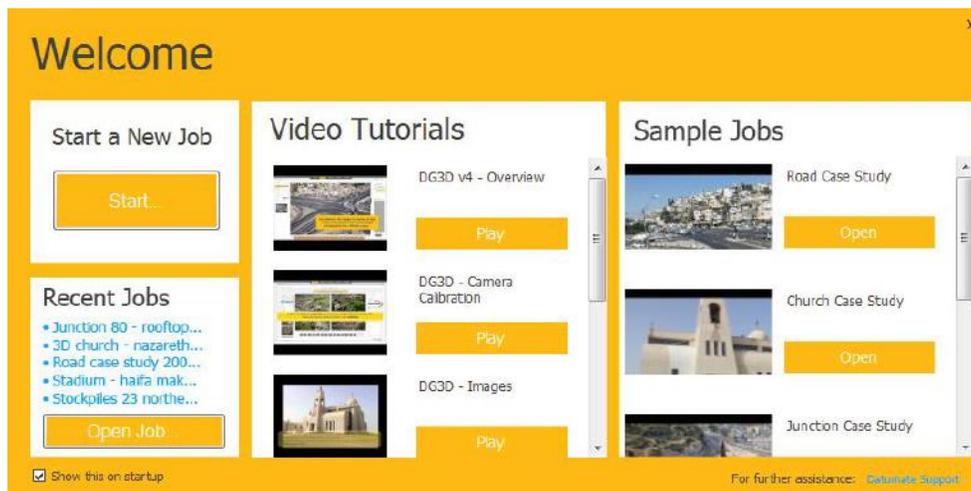


Figure 106: Welcome Screen

The Welcome window is divided into three columns:

Left Column – Mini Jobs Manager: The left column is the Recent Jobs manager. Clicking on the **Start** button, in the top square, opens the help menu that has a **Start** button which activates the Job Properties window used to create a new job.

The bottom square contains a list of links with names of recent jobs. Clicking on each link will open the linked job. Clicking the **Open Job** button will open a file dialog to let you select and open an already existing job.

Middle Column – Video Tutorials: The middle column contains internet hyperlinks to DatuSurvey™ video tutorials. Clicking on each **Play** button will open the appropriate video in

the system’s default browser. This feature requires internet connection and the latest version of Flash Player, or using Google Chrome browser.

Right Column – Sample Jobs: The right column contains links to several guided sample jobs, stored on the Datumate’s server. To use and learn from a sample job, download the job from Datumate’s server to your PC (click **Download**), and click **Open**, to view the job within DatuSurvey™. Follow instructions in the manual to work with these jobs.

7.4.4 Basic Steps Presentation

1. Click on **Before You Start** to open a series of pages containing explanations about the basic steps for using DatuSurvey™ (Figure 107 is the first slide of this series).



Figure 107: First Slide from Basic Steps Presentation



About Datumate

Datumate is a leading vendor of geodetic expert systems. Datumate software products, combining technological innovation and geodetic expertise, support land surveyors worldwide by improving productivity of field personnel, quality control and management of surveying project. Among Datumate's customers are the Survey of Israel, Israel's national mapping agency, as well as numerous leading land surveying firms worldwide.

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